

# EDN<sup>®</sup>

SPECIAL ISSUE — Part 1  
Product Showcase No 29

Highlighting key trends in  
hardware, power sources,  
integrated circuits,  
and software

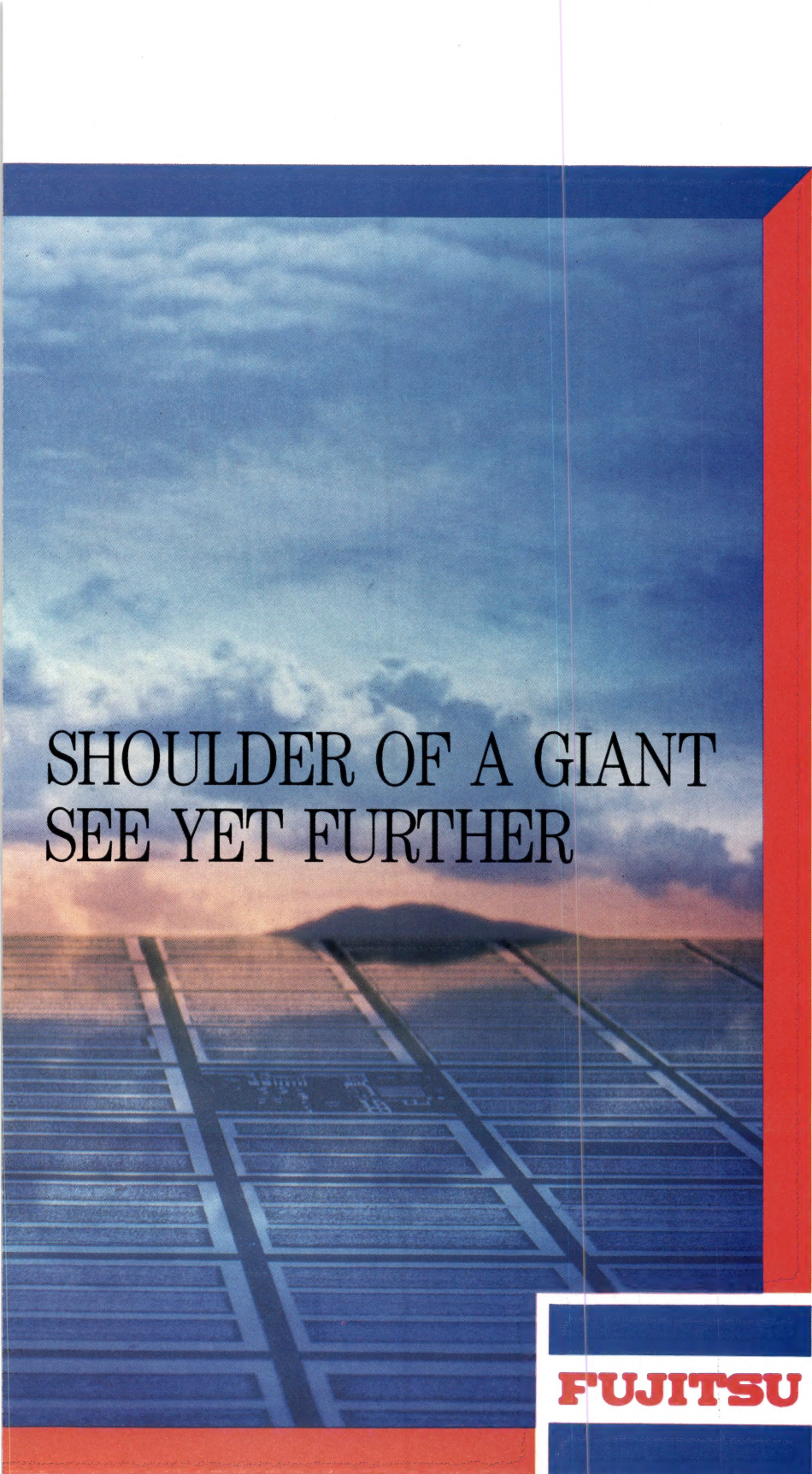
Expanded literature section

ELECTRONIC TECHNOLOGY FOR ENGINEERS AND ENGINEERING MANAGERS

## PRODUCT SHOWCASE







# SHOULDER OF A GIANT SEE YET FURTHER

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Success in electronics is no longer the domain of the individual. Today, finding a partner who offers the right combination of corporate resources and experience is the key to success in the future.

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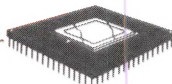
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GATE ARRAY



DRAM



DSP

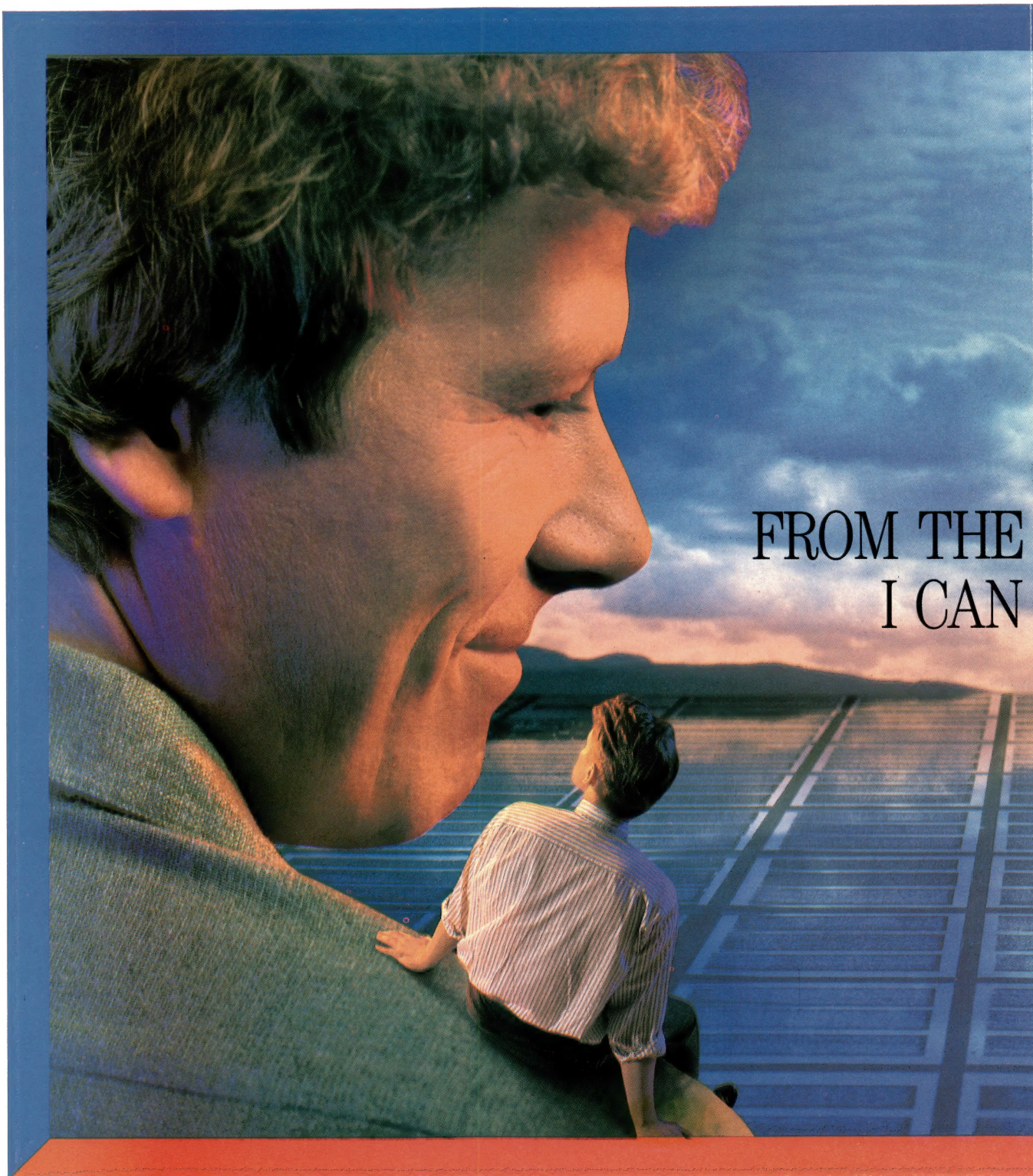


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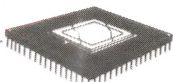


FROM THE  
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DSP



GATE ARRAY



DRAM



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SRAM

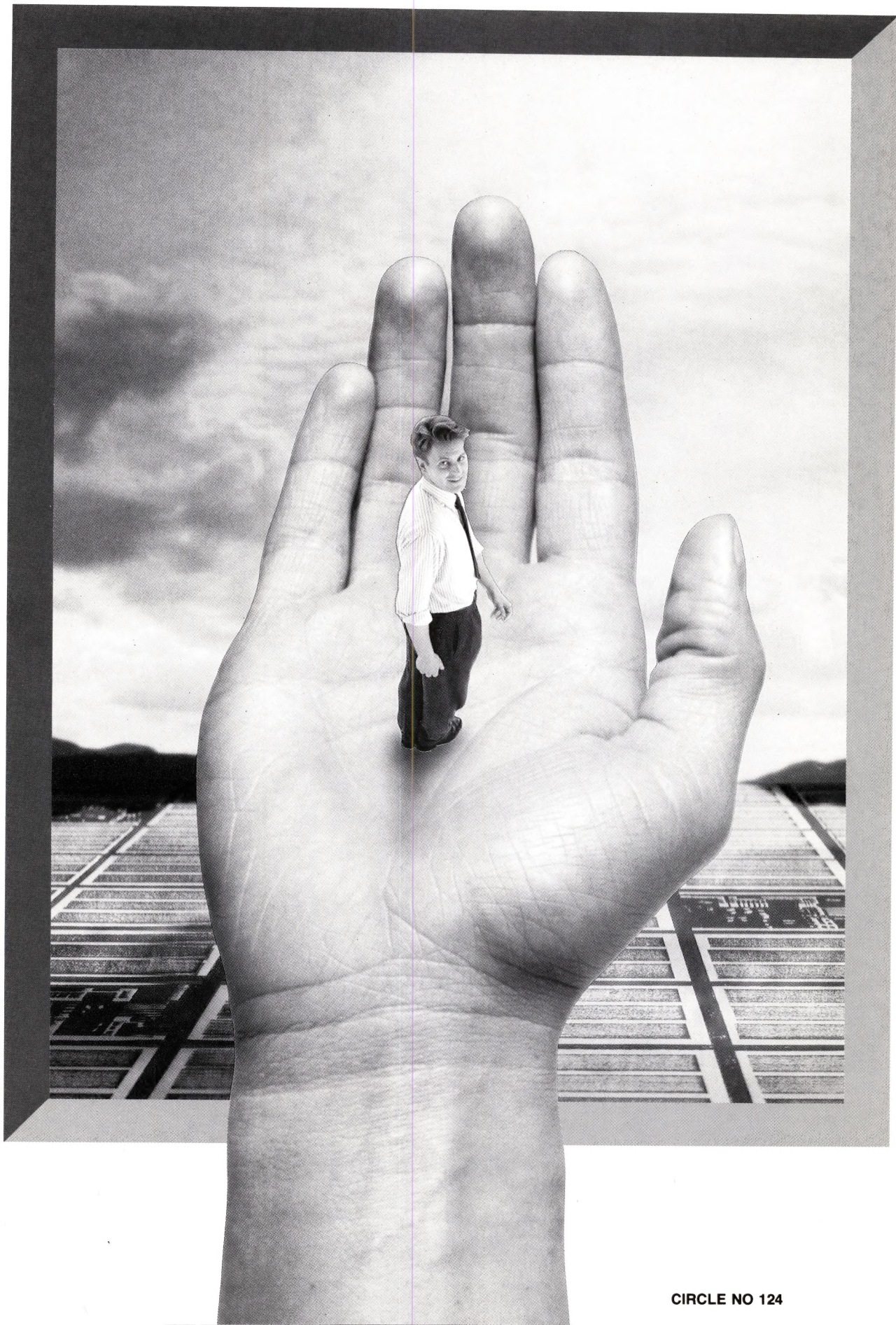


EPROM



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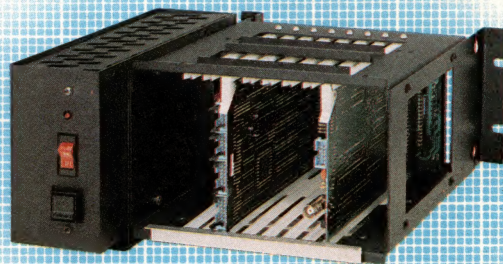
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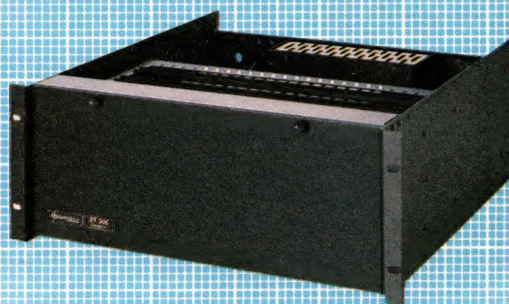
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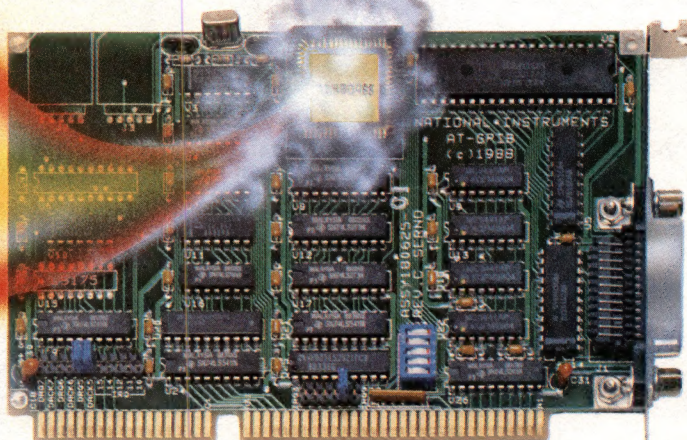
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# Maximum **IEEE-488** Performance for Your High-Speed AT Computer



## The National Instruments AT-GPIB . . . the new standard for IEEE-488 interfaces

At last, a low-cost IEEE-488 PC/AT controller board can transfer data continuously at the maximum specified rate of 1 Mbytes/sec. The key to this high performance is the state-of-the-art FIFO buffering and special last-byte handling circuitry of our custom gate array, Turbo488™. The Turbo488 also conserves valuable computer bus bandwidth by packing 8-bit IEEE-488 data bytes into 16-bit words.

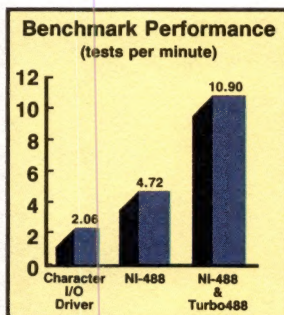
By moving time consuming software functions into hardware, the Turbo488 significantly reduces the overhead of a software driver too. The combination of the AT-GPIB and our streamlined software driver gives you the power needed for today's high speed digitizers.

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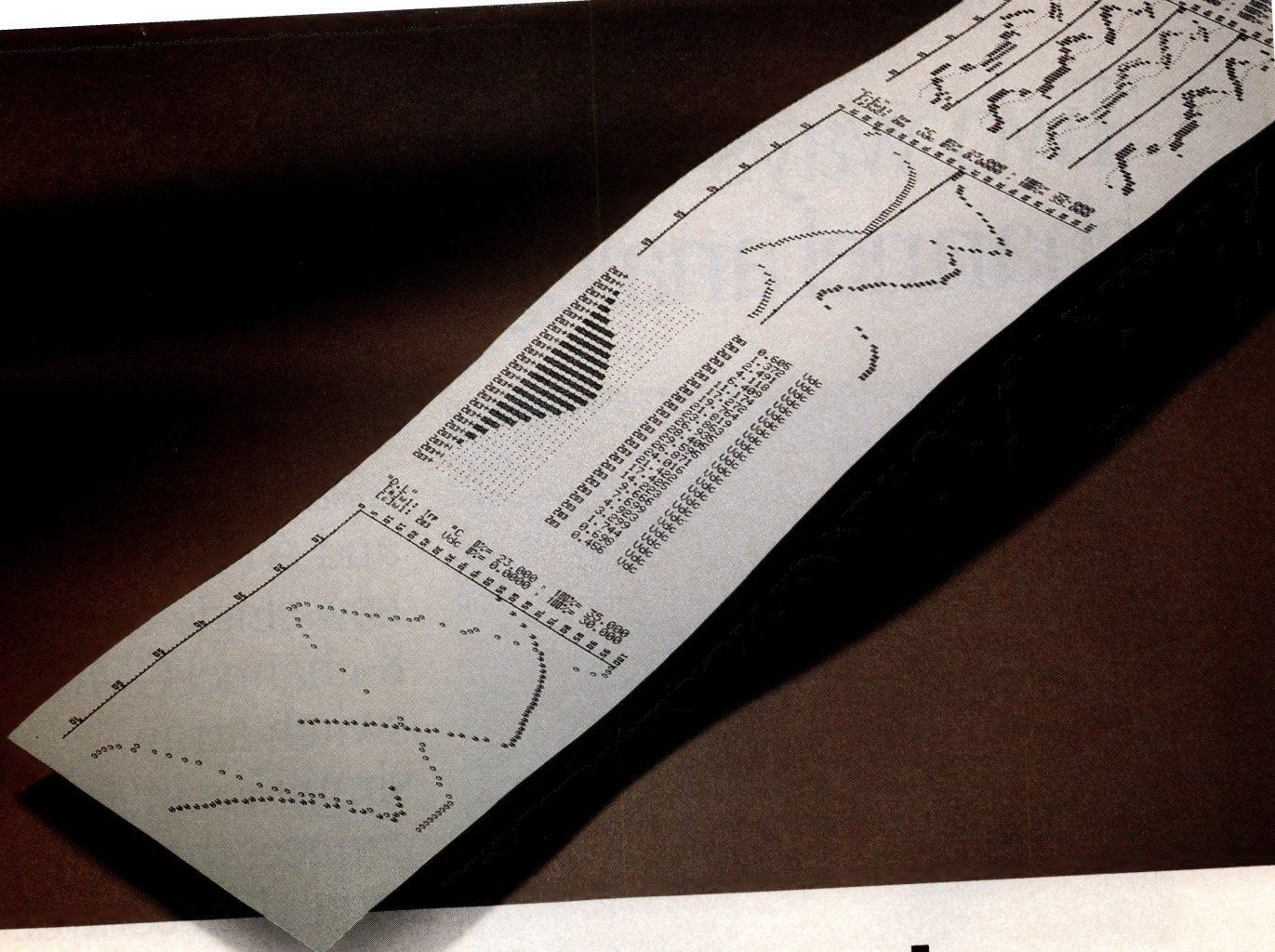


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CIRCLE NO. 102





# A plot to get you to buy our Data Logger.

As if you didn't have enough reasons already.

Our Series 50 Data Logger is a fraction the size of most other data loggers. Considerably less expensive. Completely portable.

And now, as you can see, Series 50 not only gathers data, it explains it.

You can plot from one to sixteen variables at a time. Divide the width of the page into one, two or four segments, with multiple variables in each.

If conditions change, Series 50 can be programmed to change the plot with them. For instance, it can switch to higher resolution and time-stamp data with messages during alarm conditions. And it does all this on its own, no computer needed. (On the other

hand, it can also be controlled by a computer via IEEE-488 or RS-232.)

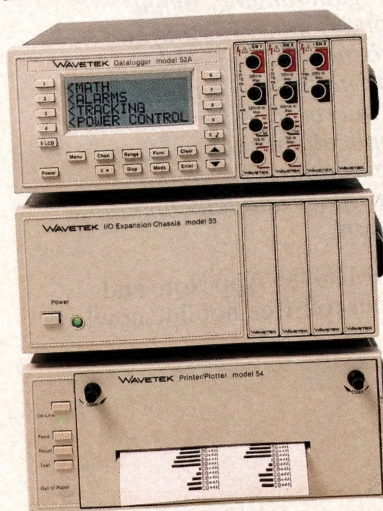
Series 50 will plot bar graphs next to numerical data. Create

min/max plots. Or generate x-y graphs from stored data.

Speaking of stored data, Series 50 can keep up to 100,000 readings in memory. Which is a good thing, because with four independent A/D converters and up to 260 channel scanning capacity, you could be gathering plenty of data.

Data such as temperatures (6 thermocouple types and RTD's), AC/DC volts and current, resistance, frequency, time period, pulse width and more.

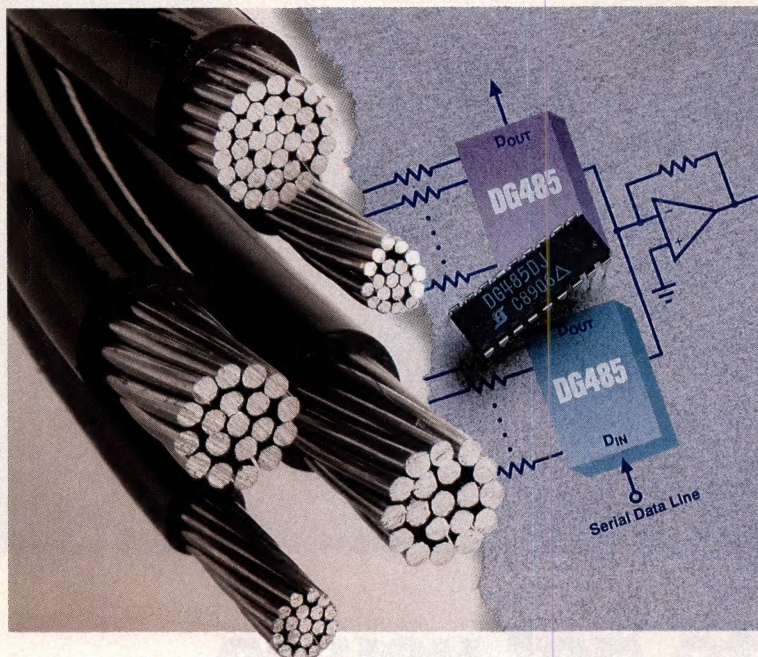
If our plot is working, you'd probably like to know more about the Series 50 Data Logger. Just phone (619) 279-2200. We'll be expecting your call.



**WAVETEK®**



# Two ways to control multi-channel analog signals.



The wire saver for instrumentation and ATE. Siliconix' new single-chip 8-channel CMOS switch array simplifies interconnect through serial data control.

Reduce the size and weight of any digitally-controlled analog system. Cut manufacturing and maintenance costs. And improve system reliability.

Now it's easy. The industry's first switch array, the Siliconix DG485, allows any combination of eight channels to output. And controls them with a serial interface that replaces most of your wiring.

A single chip—an expandable solution. You can daisy-chain DG485s to harness all the analog inputs your system requires.

## DG485 KEY PARAMETERS

Precise	$r_{DS(ON)} < 85 \Omega$
Fast	$t_{(ON)} < 200 \text{ ns}$
Efficient	$P_D < 105 \mu\text{W}$
Reliable	ESD protected $\pm 4000\text{V}$
Versatile	Any combo of 8 SPST to Output

*The versatile DG485 is ideal for gain ranging, signal conditioning, routing and mixing, channel selection and multiplexing functions in microprocessor-controlled applications such as instrumentation, ATE, audio, aerospace and telecommunications.*

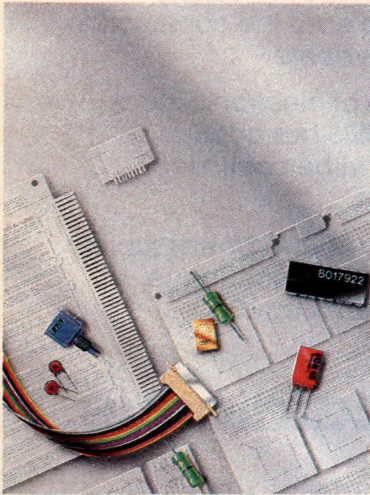
Imagine the possibilities! Ask for your DG485 App Note and Design Kit including free sample. Call our toll-free hot line now! 1-800-554-5565, Ext. 945.

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incorporated

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**On the cover:** Part 1 of EDN's Product Showcase No. 29 describes manufacturers' offerings in four product categories: power sources, integrated circuits, hardware and interconnect devices, and software. Leading off the product sections are in-depth looks at high-reliability power systems (pg 64), IC drivers for flat-panel displays (pg 102), prototyping techniques (pg 148), and real-time software kernels (pg 184). (Illustration by Thomas Szumowski; art direction by Ken Racicot)

## DESIGN FEATURES

### Power Sources

#### Modern dc power systems overcome component failures and ac outages

64

Redundancy and the use of backup power supplies aren't just for military and aerospace applications anymore. Through these techniques, commercial electronic systems—such as computers and automatic test equipment—continue to perform under conditions that would have shut down older products.—*Dan Strassberg, Associate Editor*

### Integrated Circuits

#### Specialized ICs drive flat-panel displays to new performance levels

102

The recent improvements in the size and image quality of flat-panel displays are, in large measure, the result of improved manufacturing techniques and the use of better materials. No less important, however, is the contribution made by innovative IC drivers that bring new levels of performance to these increasingly popular displays.—*Dave Pryce, Associate Editor*

### Hardware and Interconnect Devices

#### Prototyping techniques evolve to match design complexities

148

By testing your designs with some nontraditional prototyping techniques, you can satisfy that ever-present need to make sure your circuit works before committing to silicon.—*J D Mosley, Regional Editor*

*Continued on page 7*

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# To ease your power management problems . . .

Farnell has been manufacturing bench power supplies since 1958.

Now, with thirty years of leadership in the UK market, it enters its fourth decade with new, powerful units (the AP/MP series) and a very adaptable system controller (FAST) designed to ease the construction of automatic test or power management systems.

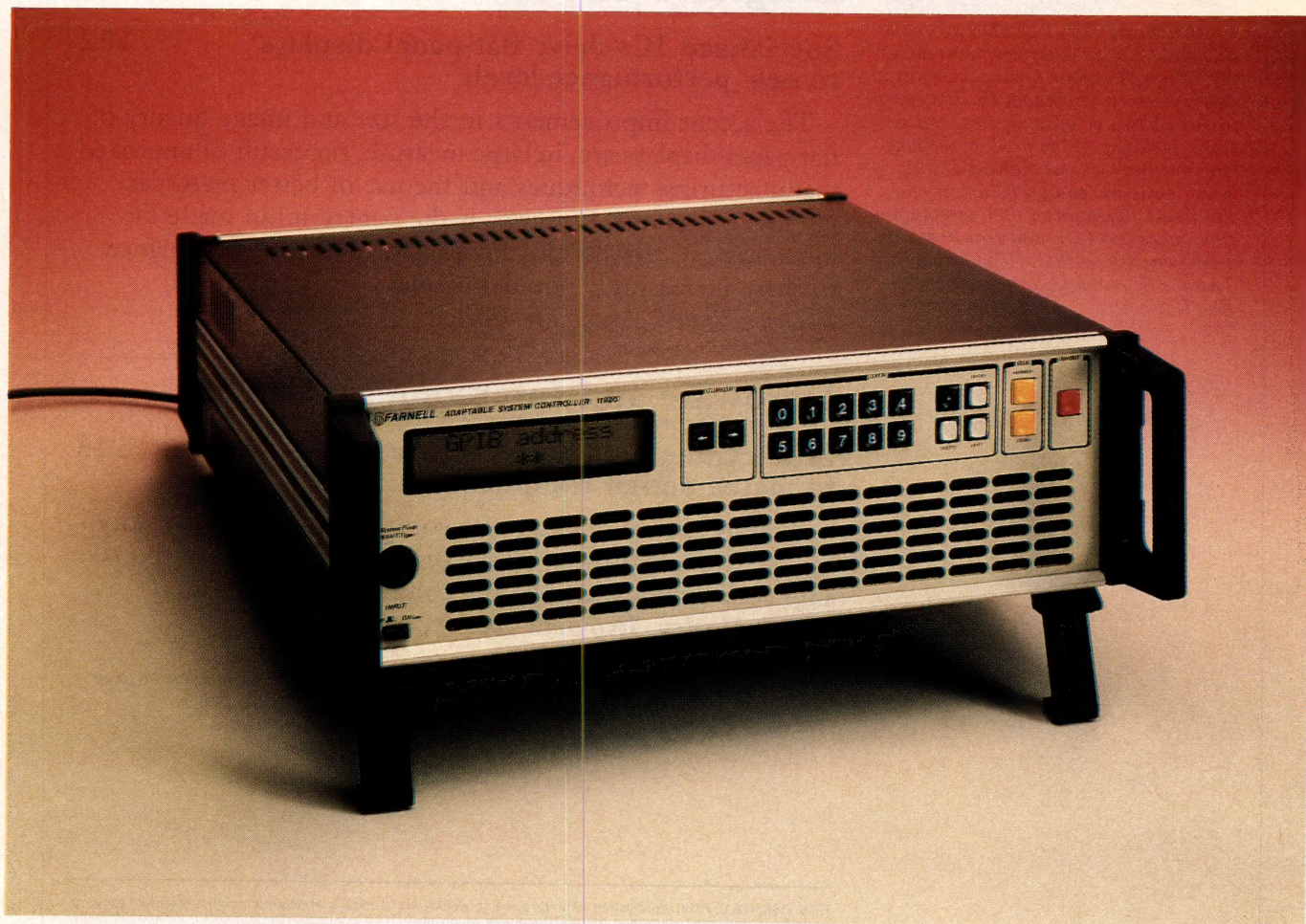
FAST is a controller with space inside for power modules or electronic loads.

FAST controls up to eight outputs from just one IEEE-488 bus address (or from the keyboard). Outputs from 60W to 12kW can be controlled with fast up/down programming times.

Quality and good value are integral components of every Farnell power supply. Our extensive range is illustrated and specified in our new catalogue.

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## . . . send for Farnell's new catalogue



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in more than sixty countries*

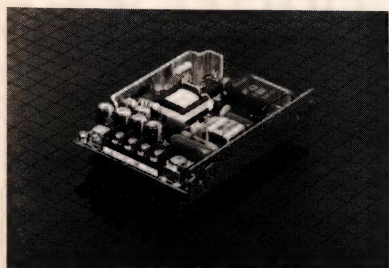


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A vast amount of products are included in EDN's Product Showcase, beginning with power sources (pg 83). Coverage continues with descriptions of ICs (pg 117), hardware and interconnect devices (pg 163), and software (pg 201).

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## Software

### Real-time kernels sprout into full-grown software environments 184

Two groups of software engineers, both unused to formal, real-time software tools, are poised to invade and overwhelm the small, cozy realm of real-time kernels.

—Charles H Small, Associate Editor

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All types of software, from system packages to application packages.	

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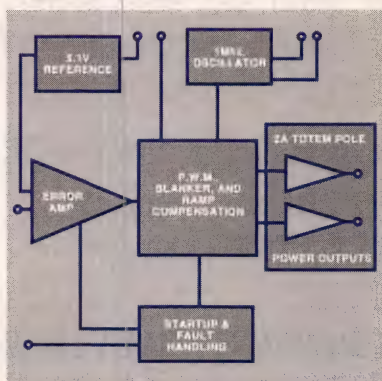
# Now you have a choice for your power supply controller.

## Standard devices for maximum performance.

**1.** Introducing three new single-chip Switch Mode Power Supply controllers that save space, money and time.

The new 16-pin ML4825 and ML4823 are improved pin-compatible replacements for the UC1825 and UC1823. A third new controller, the ML4809, is packed with extra features and functions for bet-

ter compensation, easier starting and synchronization.



*Micro Linear PWM Controllers Provide Maximum Performance*

The ML4809 starts with all the features of the ML4825, then adds even more:

### Synchronization:

- separate clock I/O pins

- wide dynamic range VCO
- toggle flip-flop output and preset inputs

### Stability:

- on-chip programmable ramp compensation
- blanker to reject turn-on spike
- completely independent error ramp

### Start-up/Fault conditions:

- 7V hysteresis on under-voltage lockout
- full reset with programmable delay

If one of these new standard controllers doesn't meet your special high-frequency system needs, Micro Linear can provide a customized solution to your specific applications.

PART TYPE	SOFT START RESET	UNDER-VOLTAGE OUTPUT STATE	COMPARATOR TO OUTPUT DELAY
ML4823-5	COMPLETE	LOW	40 nS
UC1823-5	PARTIAL	FLOAT	50 nS

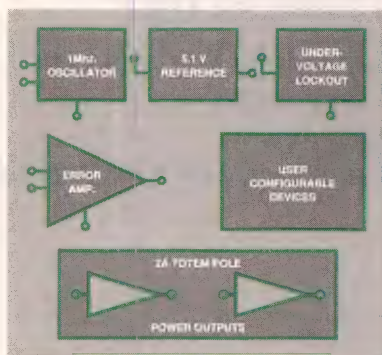
*Micro Linear/Unitrode Comparison*

## ASIC devices for maximum flexibility.

**2.** Announcing the new FB3480, the first semi-custom array specifically designed for high frequency Switch Mode Power Supply applications.

Unlike most other semi-custom IC's, the FB3480 is specifically designed for SMPS control. This array contains specially crafted high performance "core cells" optimized to perform the functions found in all PWM controllers. In addition, a large area of uncommitted components on the chip can be configured to your specifica-

tions using Micro Linear's library of "soft macros." These macros implement a full complement of logic, comparator



*ML3480 Array Enables Easy Custom Design*

and other functions which make your controller unique. This "core cell" and "soft macro" design approach provides a customized solution with a minimum of cost and effort, without sacrificing performance.

For more information on the new single-chip standard and semi-custom SMPS controllers from Micro Linear, call (408) 433-5200, ext. 900.

Or write:

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Shareholders should include engineers and managers, along with top management, for good performance.

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## A product-oriented design aid

To save you time in your efforts to keep current, EDN's editors have surveyed the new-product offerings from thousands of companies, screening and selecting only the most significant of those offerings introduced in the last six months. We present our findings—the best of the best—in a format devised to make your product selection as easy as possible. You can keep this Product Showcase as a reference until the next one that covers these four key product areas appears in December.







# It's an Analog World.

**Ultimately, all circuits are analog circuits. That's why you should step into the analog EDA world of Mentor Graphics.**

Here you will find advanced design automation that guarantees high quality results. Gets you to market sooner. And still leaves you time to explore creative alternatives.

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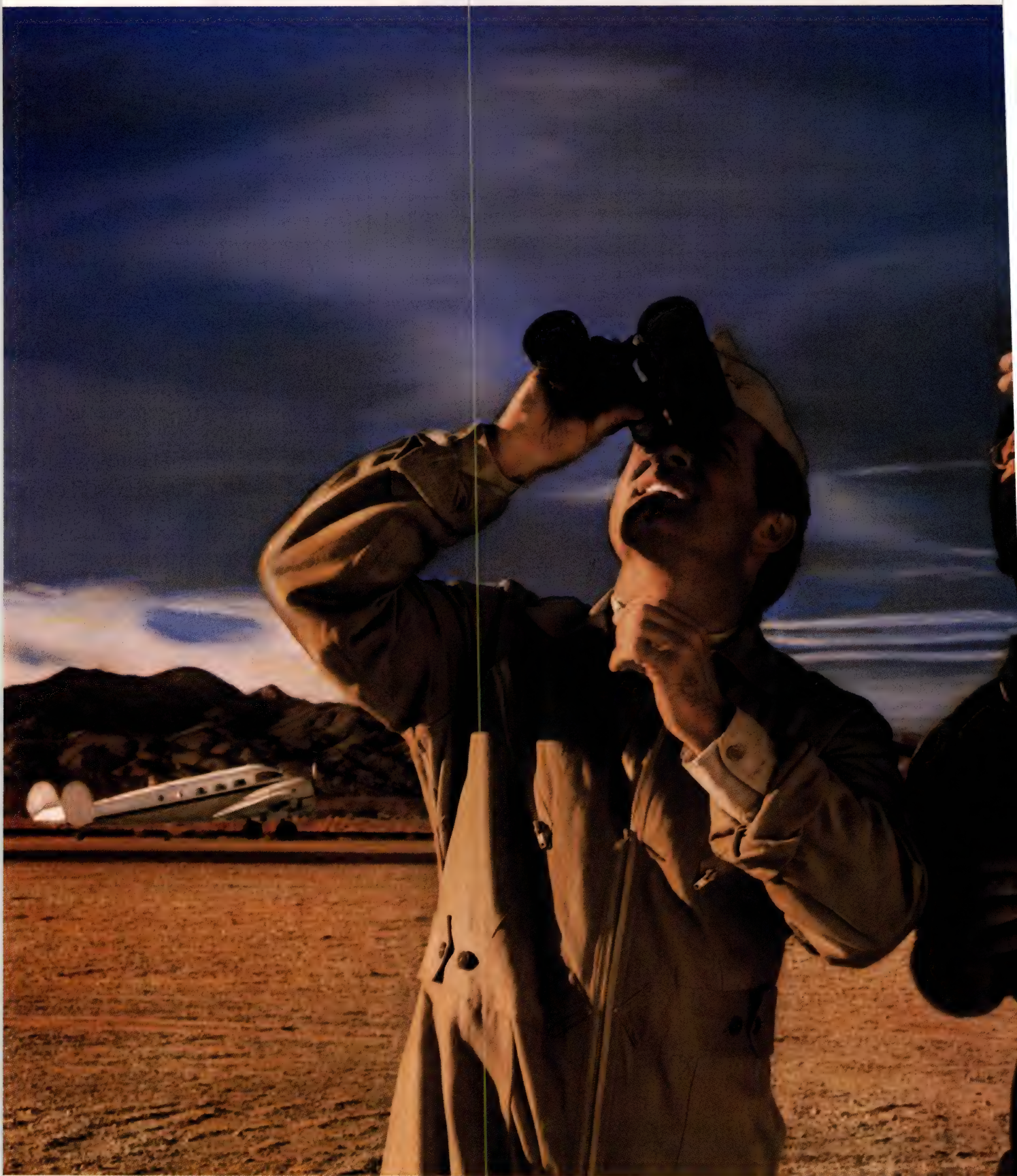
For a brochure on the Mentor Graphics analog world, dial this digital, toll-free number: **1-800-547-7390**.



*Your ideas. Our experience.*



# Who was the second person



Captain James Fitzgerald was the second person to break the sound barrier at Muroc Dry Lake, on February 24, 1948.



# o break the sound barrier?

Someone worked every bit as hard as Chuck Yeager and came in second. The sad truth is, no matter how fast you go, getting there second isn't fast enough.

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Take our 32-bit RISC microprocessor, the 29K™. At 17 MIPS, it's at the heart of some of the fastest, most powerful equipment now being built.

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Which makes it easy for you to go out and get your share of the profits before anyone else gets off the ground.

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# Isolated Power MOSFETS

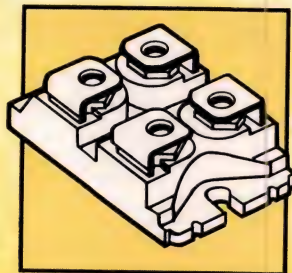
## 1000 Volts, 14mOhm, 3 Packages

### One Leader.

Switch to the leader in POWER MOSFET isolated package technology, SGS-THOMSON Microelectronics, from day one you'll get isolated power that will help blast you right past your competition. The SGS-THOMSON range of power MOSFET devices in the emerging industry standard ISOTOP™ power packages is truly exceptional ranging from high voltage devices like the 1000V TSD5MG40 to high current devices like the 14mOhm TSD4M150.

The high performance ISOTOP package takes up no more real estate than a standard TO-3 but it has advantages that leave the others standing.

- 2.5 kVrms internal insulation
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- Low internal parasitic inductance  $<5\text{nH}$
- Low parasitic Capacitance  $<45\text{pF}$
- Improved reliability
- Reduced EMI and RFI
- Multiple mounting on a single heatsink
- Connections on track side of board
- Easy assembly
- One device replaces 4 or 5 standard devices



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Now read the bottom line - Lower costs.

If it all sounds too good to be true just check out how much it costs to use standard devices. First you'll need 4 or 5 plus all their isolating components, plus the extra heatsinks, plus the extra space you'll need to mount them. Then add on the cost of assembling all the different parts plus the cost of the extra inventory.

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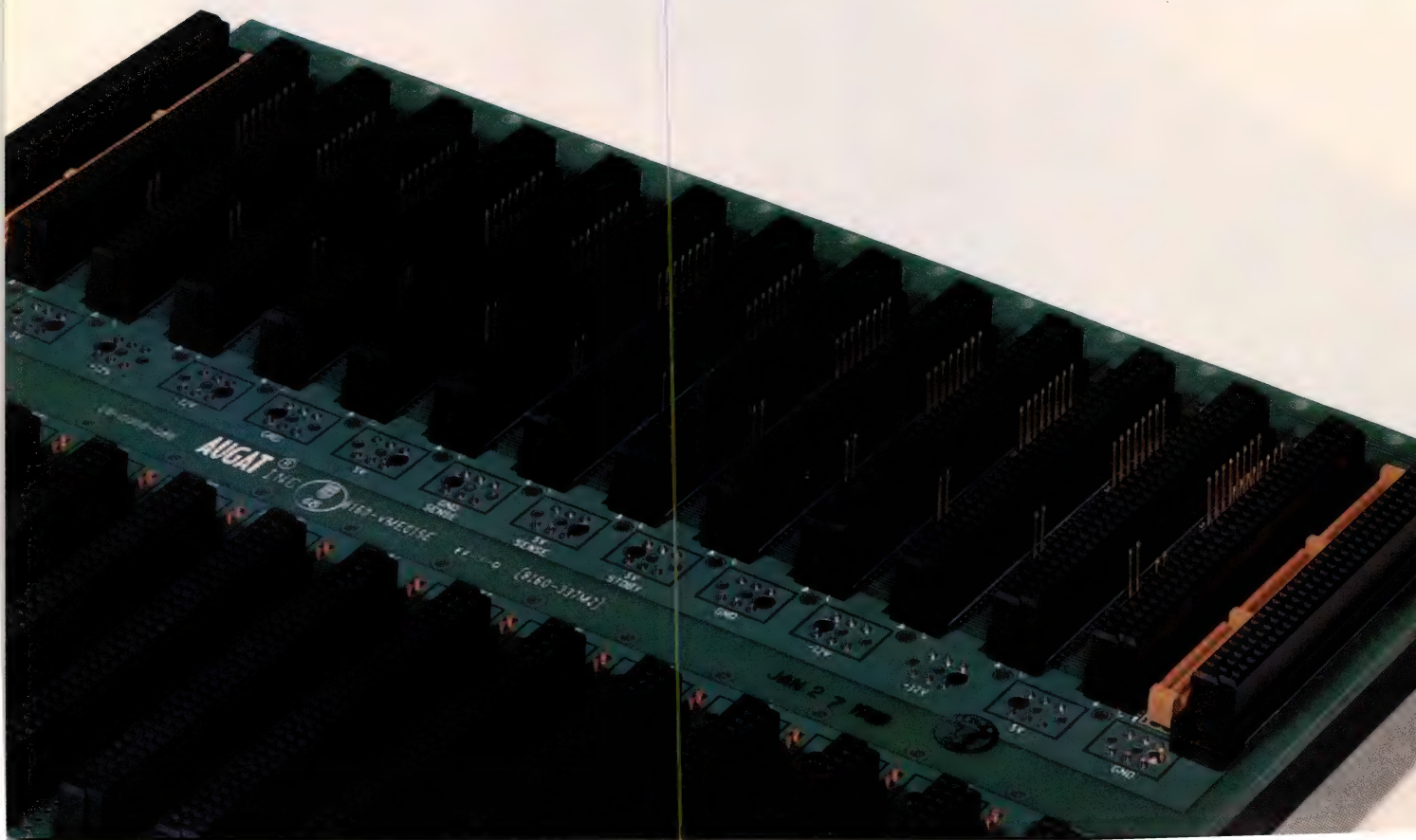
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\*AUGAT GUARANTEES to ship backplanes and/or card cage kits in any size (from 3 through 21 slots) in 7 working days from date of approved credit — or you pay 20% less! (limit: 3 pieces per part number)

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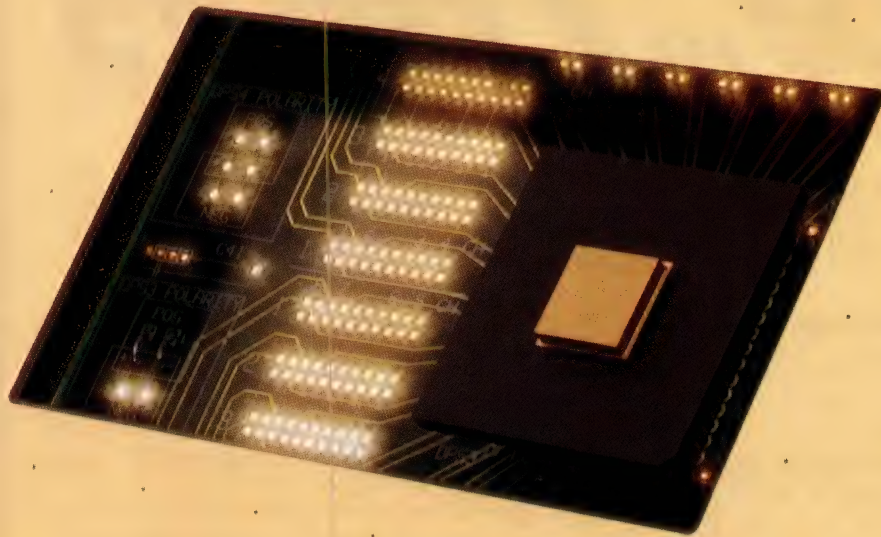
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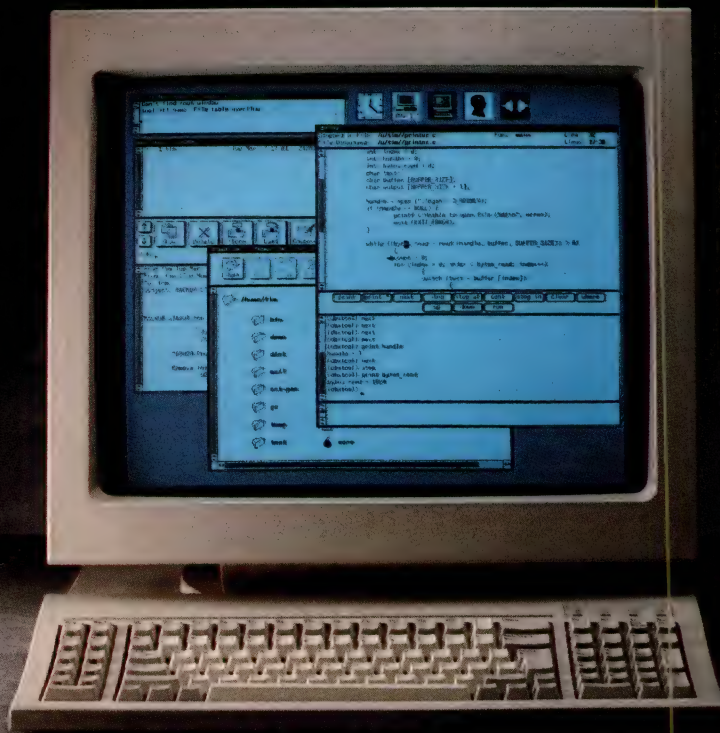
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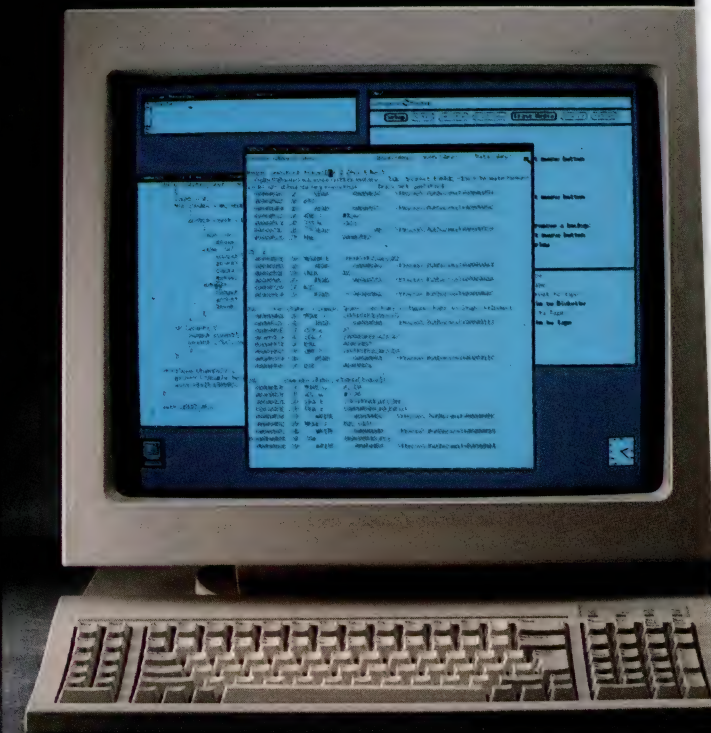


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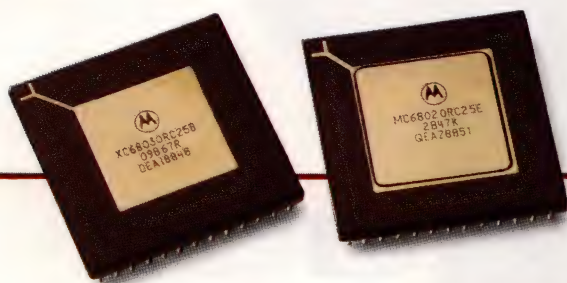


trace capability lets you examine program flow at the C, Ada®, or assembler level. And eight hardware breakpoints let you find sequence-dependent bugs.

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# NEWS BREAKS

EDITED BY JULIE ANNE SCHOFIELD

## **CAD VENDOR ENHANCES SIMULATION SUITE**

Viewlogic (Marlboro, MA, (508) 480-0881) announced its enhanced Workview tool set, which has a VHDL (VHSIC Hardware Description Language) capability that supports system-level simulations of any mixture of VHDL-behavioral circuit descriptions and gate-level descriptions, at the Design Automation Conference last week. This simulation capability can be extended with the LM1000 Hardware Modeler from Logic Modeling (San Jose, CA, (408) 922-0870) and with software models from Logic Automation (Beaverton, OR, (503) 690-6900) and Quadtree Software (Bridgewater, NJ, (201) 725-2272). To convert from behavioral- to gate-level circuit descriptions, Workview also has a logic-synthesis capability. If you want to supplement the functions on Viewlogic's software, the vendor supports an open-architecture CAD system using EDIF 2.0 (Electronic Data Interchange Format) as a transfer database, so you can access and transfer data between Viewlogic's software and other EDIF-compatible applications. Viewlogic also announced at the conference that its front-end software can be ported from both PC/AT compatibles and Sun workstations to the new DECstation3100.—Michael C Markowitz

## **SEA-OF-GATES LAYOUT SYSTEM USES DISTRIBUTED PROCESSING**

The Parallel Rene-GA Sea-of-Gates IC-layout system from Descartes Automation Systems Inc (Santa Clara, CA, (408) 986-8877) runs on computer platforms that range from engineering workstations to IBM mainframes. Aimed at design complexities of 20,000 gates and more, the software uses conventional networking and no special hardware to achieve distributed-processing speed improvements. The software performs serial placement then automatically or manually partitions the layout into modules. Next, a single processor performs global routing between modules. The software performs routing within modules—the bulk of the work—using distributed processing. This scheme lets multiple networked engineering workstations achieve the throughput of more expensive mainframe computers. The manufacturer claims six \$25,000 workstations using its software outperformed a multimillion-dollar mainframe in preliminary benchmarks. Each system is tailored to the specifications of individual customers, and prices start at \$150,000.—Doug Conner

## **FILTER STORES PROGRAMMING IN EEPROM**

The SC22324 switched-capacitor filter from Sierra Semiconductor (San Jose, CA, (408) 263-9300) lets you implement an eighth-order filter in a single device with a bandwidth as great as 100 kHz. The device is cascadable for higher-order filters. It accepts serial data and stores its programming data in temporary registers whose contents can be transferred to EEPROM for nonvolatile storage. The device can operate from either the temporary or EEPROM data, thus letting you implement adaptive filtering. The device also offers two undedicated op amps for analog-filtering needs and a programmable filter clock counter. The SC22324 costs \$49 (100). A designer's kit, including filter-design software, a programming station, a textbook, and two sample devices, is available for \$1875.—Richard A Quinnell



# NEWS BREAKS

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## **CAD-TOOL VENDORS LAUNCH VHDL VALIDATION-SUITE PROJECT**

A group of CAD-tool vendors has started a VHDL (VHSIC Hardware Description Language) validation-suite project, to be led by Dr James Armstrong of Virginia Polytechnic Institute (Blacksburg, VA, (703) 231-4723). This test suite will serve as a standard to ensure and promote compliance with the IEEE's VHDL standard. The sponsoring companies include CAD Language Systems Inc, Daisy Systems, GenRad, MCC, Vantage Analysis Systems Inc, and Zycad Corp. Sponsoring companies have submitted their internally developed tests for consideration. Tests are judged using 1100 criteria. The National Institute of Standards and Technology is coordinating the project and will maintain the test-validation suite after government funds are allocated for the task.—Steven H Leibson

## **VENDORS CHOOSE SIDES OVER HIGH-RES GRAPHICS STANDARD**

Expect IC vendors to introduce 8514/A-compatible graphics ICs from now through the end of the year. Manufacturers wishing to copy the PC/AT and PS/2 graphics standard developed by IBM first had to reverse-engineer the part to determine its registers. (Knowledge of the graphics adapter registers lets software developers bypass the software interface, thus resulting in faster programs.) Western Digital Imaging (Mountain View, CA (415) 960-3353), the first company to publicly release its version of the registers, can now deliver sample chips. Chips and Technologies (San Jose, CA (408) 434-0600) has announced its version of the registers and says it will deliver samples in August. And expect a similar announcement from Headland Technology (Fremont, CA, (415) 656-7800). All these companies are spurred by the promise of a huge market for a universally accepted high-resolution graphics display for PCs. Some market watchers predict monitor/adaptor combinations supporting the 8514/A standard's 1024×768-pixel resolution and 256 colors and priced under \$1000 will be available within 18 months.

Not all companies in the PC-graphics market are convinced of the 8514/A's imminent success. Cirrus Logic (Milpitas, CA (408) 945-8300), for example, figures that the high-resolution PC-graphics market will be too fragmented and that the 8514/A's drawbacks, such as a slow software interface, limited graphics primitives, and an interlaced display, will limit its acceptance. Look for Cirrus to develop a chip that lets graphics boards based on Texas Instruments's TMS34010 graphics processor maintain compatibility with the lower-resolution PC-graphics standard, the VGA.

—Margery Conner

## **CONVERTER LINKS ETHERNET LAN AND SCSI BUSES**

The Ether+ from Compatible Systems Corp (Boulder, CO, (303) 444-9532) converts the SCSI port of Apple Computer's Macintosh into an Ethernet node and accommodates both thick and thin Ethernet cables. The \$495 converter supports the Macintosh's built-in software communications protocols and the TCP/IP Ethernet standard. It can also be modified to support other network protocols. The Ether+ is compatible with several existing Macintosh network programs including AppleShare, TOPS, and Novell Inc's Netware. At 10M bps, the Ethernet LAN is approximately 40 times faster than Apple's AppleTalk/LocalTalk network.—Steven H Leibson





# The Glitch is History

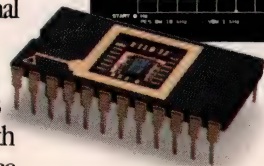
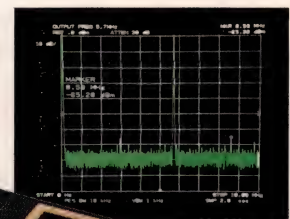
The Glitch won't disturb performance or raise the cost of your design again. Not if you specify TRW LSI's high speed 12-bit DAC. Because our TDC1012 is virtually glitch-free. It settles to  $\pm 0.012\%$  of full-scale within 30ns. It operates at data rates to a guaranteed minimum of 20MHz, and reduces spurious harmonics to -65dBc or less, all without need of a sample-and-hold.

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Segmented architecture that replaces the outmoded R-2R ladder, along with several other proprietary design enhancements help account for the TDC1012's record-setting performance. It belongs in your next digital RF, IF or waveform synthesizer, vector graphic display — or anywhere you need a fast, high resolution, distortion-free DAC. It's available now in ceramic or plastic DIP packages from TRW LSI Products or your nearest Hall-Mark or Hamilton/Avnet location. If you need a faster 12-bit DAC, specify our 50MHz TDC1112.

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# NEWS BREAKS

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## **LOGIC ANALYZERS NOW HANDLE 35-MHz STATE ANALYSIS**

In the two years since their introduction, the 1650A and 1651A logic analyzers and the 16500A logic-analysis system from Hewlett-Packard Co (Colorado Springs, CO, (800) 752-0900) have been extraordinarily successful because of their outstanding price/performance ratio. Now, HP has upgraded the products and is holding the line on most prices. The \$7800, 80-channel, 1650B and the 400-channel-max 16500A (\$12,600 when equipped with the 16510B logic-analyzer module) now offer 35-MHz state analysis; the earlier versions operated at 25 MHz in state-analysis mode. The timing-analysis speed of the new versions remains 100 MHz. The \$3900, 32-channel 1651B, which is used primarily on 8-bit systems, retains its predecessor's 25-MHz state-analysis speed but shares several other improvements with the 1650B and upgraded 16500A, such as the addition of compare-, chart-, and state-waveform display modes. The 16500A now permits 160-channel trigger qualification; it previously could use only 80 channels for triggering. HP is offering methods of adding most of the new and upgraded capabilities to existing 1650As, 1651As, and 16500As and is adding support for the 68030, 80386, AM29000, and NS32532  $\mu$ Ps.—Dan Strassberg

## **PACKAGE ALLOWS STD-BUS MULTIPROCESSING**

Your STD Bus-based system may benefit from the speed advantages of multiprocessing when you partition system control functions into smaller tasks and assign each subtask to a V40-based ZT 8832 I/O control processor (ICP) from Ziatech (San Luis Obispo, CA (805) 541-0488). This board contains 800k bytes of RAM, two serial ports, three parallel ports, an interrupt controller, three 16-bit counter-timers, a 2-stage watchdog timer, optional battery backup, and an SBX multi-module expansion socket with DMA capability. The ICP communicates with a master STD Bus processor through 32k bytes of shared memory, which is physically located on the ICP but mapped into the system's main memory. The board comes with the DOS Multiprocessing Extension (DOS MPX) software support package, which provides an operating system and development environment to support multiple ICPs as DOS devices. The board costs \$785.—Margery Conner

## **PC-BASED DSP CARD SPECS 33M-FLOP PERFORMANCE**

A \$2495 add-in card for IBM-compatible PCs called the Spirit-30 performs 33M flops. Sonitech International Inc (Wellesley, MA, (617) 235-6824) offers the board, which is based on the Texas Instruments TMS320C30 DSP  $\mu$ P and targets applications such as signal processing, array processing, and graphics. Software support for the board includes a DSP library, a C compiler, a debugger, and a real-time operating system. The board includes 128k bytes of 25-nsec static RAM, which is dual ported between the TMS320C30 and the PC host bus. You can add an additional 512k bytes of static RAM via a daughter card. In addition to the PC host-bus interface, the accelerator board includes six expansion connectors that support external devices such as memory boards, data-acquisition boards, and graphics products.

—Maury Wright



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Push down  
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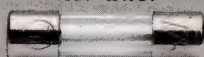
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# Talk to Littelfuse.

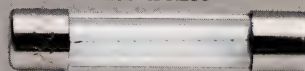
2AG Fuse  
.177" x .580"



5x20mm Fuse  
.197" x .787"



3AG Fuse  
.250" x 1.250"





# 99¢

from



## dc to 2000 MHz amplifier series

### SPECIFICATIONS

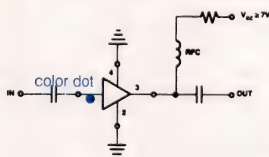
MODEL	FREQ. MHz	GAIN, dB				• MAX. PWR. dBm	NF dB	PRICE \$ Ea.	Qty.
		100 MHz	1000 MHz	2000 MHz	Min. (note)				
MAR-1	DC-1000	18.5	15.5	—	13.0	0	5.0	0.99	(100)
MAR-2	DC-2000	13	12.5	11	8.5	+3	6.5	1.50	(25)
MAR-3	DC-2000	13	12.5	10.5	8.0	+8□	6.0	1.70	(25)
MAR-4	DC-1000	8.2	8.0	—	7.0	+11	7.0	1.90	(25)
MAR-6	DC-2000	20	16	11	9	0	2.8	1.29	(25)
MAR-7	DC-2000	13.5	12.5	10.5	8.5	+3	5.0	1.90	(25)
MAR-8	DC-1000	33	23	—	19	+10	3.5	2.20	(25)

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80 x 50	10%	X7R	2200, 4700, 6800, 10,000 pf
120 x 60	10%	X7R	.022, .047, .068, .1μf

† Minimum Order 50 per Value  
• Designers kit, kcap-150 pieces of each capacitor value, only \$99.95





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LOW PASS	Model	*LP-	10.7	21.4	30	50	70	100	150	200	300	450	550	600	750	850	1000
Min. Pass Band (MHz) DC to			10.7	22	32	48	60	98	140	190	270	400	520	580	700	780	900
Max. 20dB Stop Frequency (MHz)			19	32	47	70	90	147	210	290	410	580	750	840	1000	1100	1340
Prices (ea.): Qty. (1-9) P \$11.45, B \$32.95, N \$35.95, S \$34.95																	

HIGH PASS	Model	*HP-	50	100	150	200	250	300	400	500	600	700	800	900	1000
Pass Band (MHz)															
start, max.			41	90	133	185	225	290	395	500	600	700	780	910	1000
end, min.			200	400	600	800	1200	1200	1600	1600	1600	1800	2000	2100	2200
Min. 20dB Stop Frequency (MHz)			26	55	95	116	150	190	290	365	460	520	570	660	720
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\*Prefix P for pins, B for BNC, N for Type N, S for SMA example: PLP-10.7

C105 REV. E



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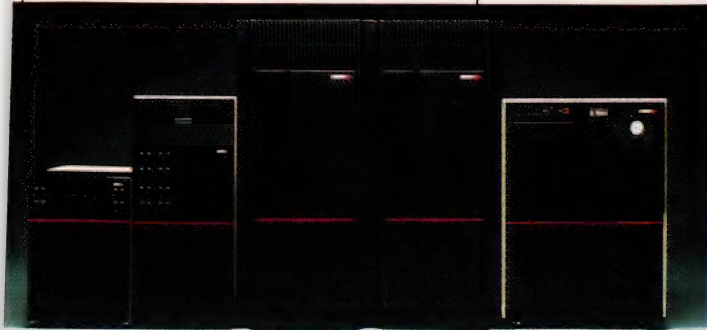
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choice should be Teradyne, too. To find out how we



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# SIGNALS & NOISE

## In design, expect the worst

I really enjoyed your recent series on troubleshooting by Bob Pease (EDN, January 5 through March 2, 1989). Although I'm not much of an analog designer, I have gained experience over the years in digital-system design, development, and debugging. Very few people can appreciate the artistic or "seat-of-the-pants" techniques we apply. I recently supervised somebody in the design of a circuit pack. It took him *a few days* to do the actual logic design. It took him several months (on and off) to prepare that design so that somebody could actually build it (a printed-circuit board). He was amazed. He never learned any of that in school. He still has to get the circuit pack, get parts (a non-trivial task), and *debug* it. Needless to say, it's quite an educational ex-

perience for a novice. Even for an experienced designer like me, it's no trivial task.

This fact is probably responsible for the attitude I have developed over the years: I expect the worst and am surprised when anything works at all. I am rarely disappointed. I design with this philosophy in mind. (I detected this philosophy in Bob's articles, too.)

I run into many people with the opposite frame of mind: They expect the best and are surprised when it doesn't work. I have little patience with these people. They are either geniuses (and I have met two or three of those over the years in this trade), or they've never gone through the design and debug process. It is a truly humbling process.

One more comment touched on in Bob's article: People are continually amazed when I tell them that I

solve most of my problems at my desk with an *ohmmeter*. That fact simply points to where over half the problems have occurred over the years—in interconnections.

*John D Loop  
Research Engineer  
BellSouth Services  
Atlanta, GA*

## Some pc-board cautions

Robert A Pease has been writing an excellent series of articles, as he always does. This series reminds me of the old days when I used to be able to fix things. It's necessary to pass this type of wisdom along to each generation to keep common sense in the field of engineering development.

However, as with all us old timers, he slipped on a few points, to wit: Eyelets are out, especially in multilayer boards. They are still

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OK for 2-sided experimental boards and single-sided boards where changes in components are desired. In the latter case, an eyelet socket is used during development, then solder is applied to the finished circuit to hold everything stable. Using an eyelet in a multilayer board will distort the plated barrel, frequently causing separation from the inner layers of copper. This shows up only as a temperature-induced, intermittent problem during testing; it will become a hard failure only when it gets to the customer, or is in the field. Good plating shops can create excellent plated-through holes at a reasonable cost today, so

give them a try.

The use of lock washers on printed wiring boards is fraught with danger. We spent a lot of money at one company in trying to find out why our screws kept backing out of their holes, causing the boards to come loose in their mounts. The problem happened during a thermal/vibration test. Running the same boards through the vibration test without the thermal test did not loosen the screws. Thermal cycling was the culprit. It caused the board to expand, and near the glass transition temperature (125°C), it caused the board to deform to relieve the stress. When the assembly cooled, there was no incentive for the material to flow back into the gap; thus, the board was loose. A spring washer, be it a star or a Belview type, will eventually loosen to the point that the desired electrical connection is poor, if not lost altogether. It's better to solder if you can. If a screw is needed, make the pad very large and the washer under the screw wide, in order to spread the load and maximize the joint's life.

Keep the good practical articles coming, and we will all benefit.

*Richard T Lamoureux*  
Hawthorne, CA

**From Bob Pease**

Dan Sheingold of Analog Devices recently pointed out to me that Analog Devices' *Data Converter Handbook* has a few pages of advice on troubleshooting. I looked there, and he is quite right; there are some good notes and ideas about troubleshooting, about eight pages, including even several items I forgot to include in my 5-part series on the subject. Any serious student of troubleshooting is encouraged to look in that book. There may be a lot of overlap with my writing, but the slightly different viewpoints may prove valuable to the reader.

*Robert A Pease*  
Contributing Editor

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# Data Converter Choices Holding You Up?

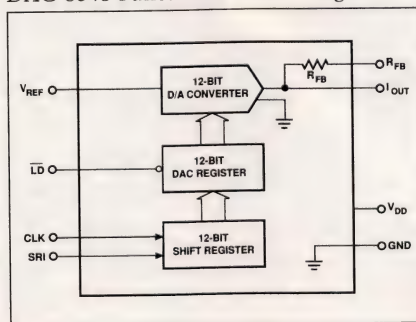
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*DAC-8043 Functional Block Diagram*



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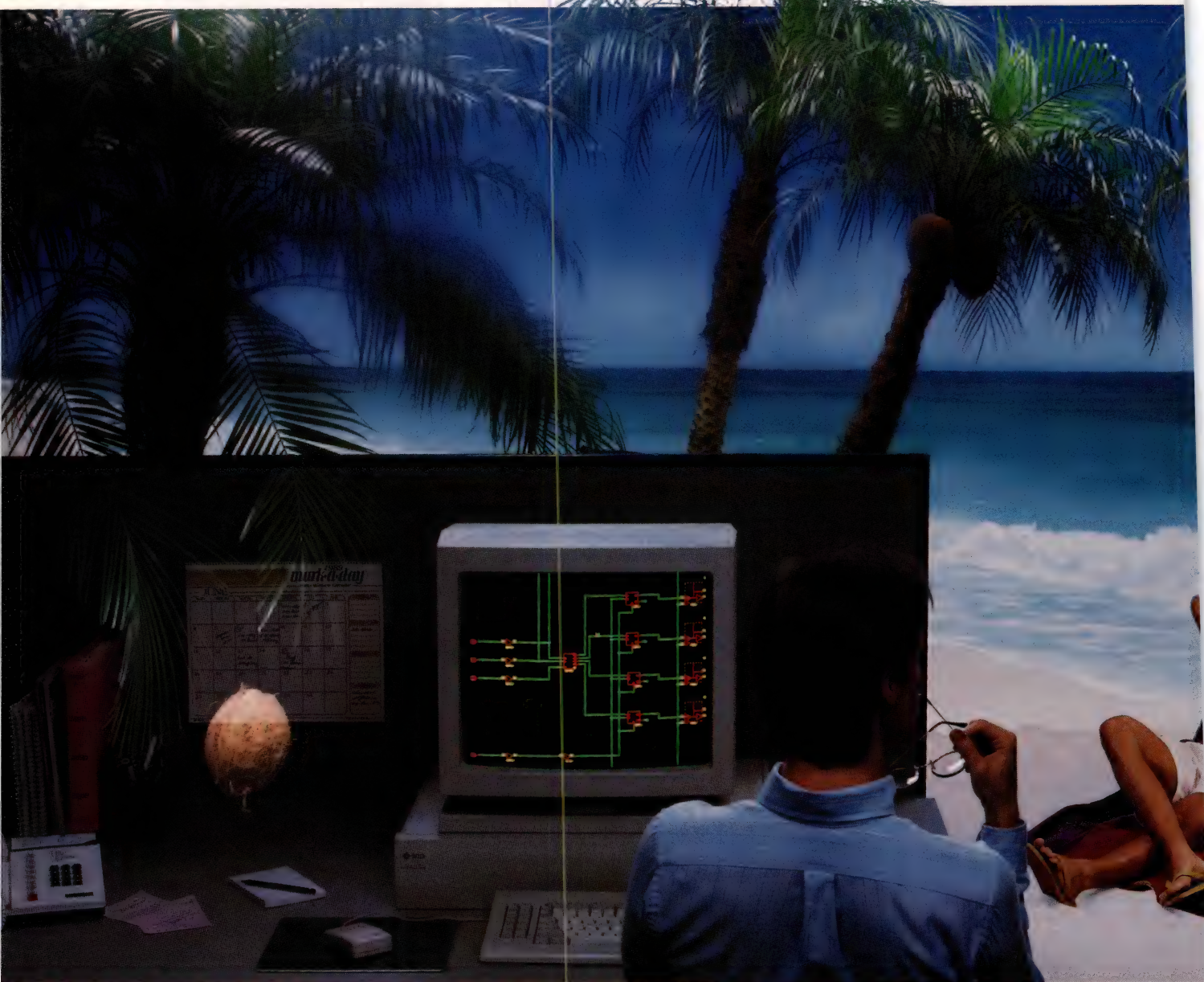
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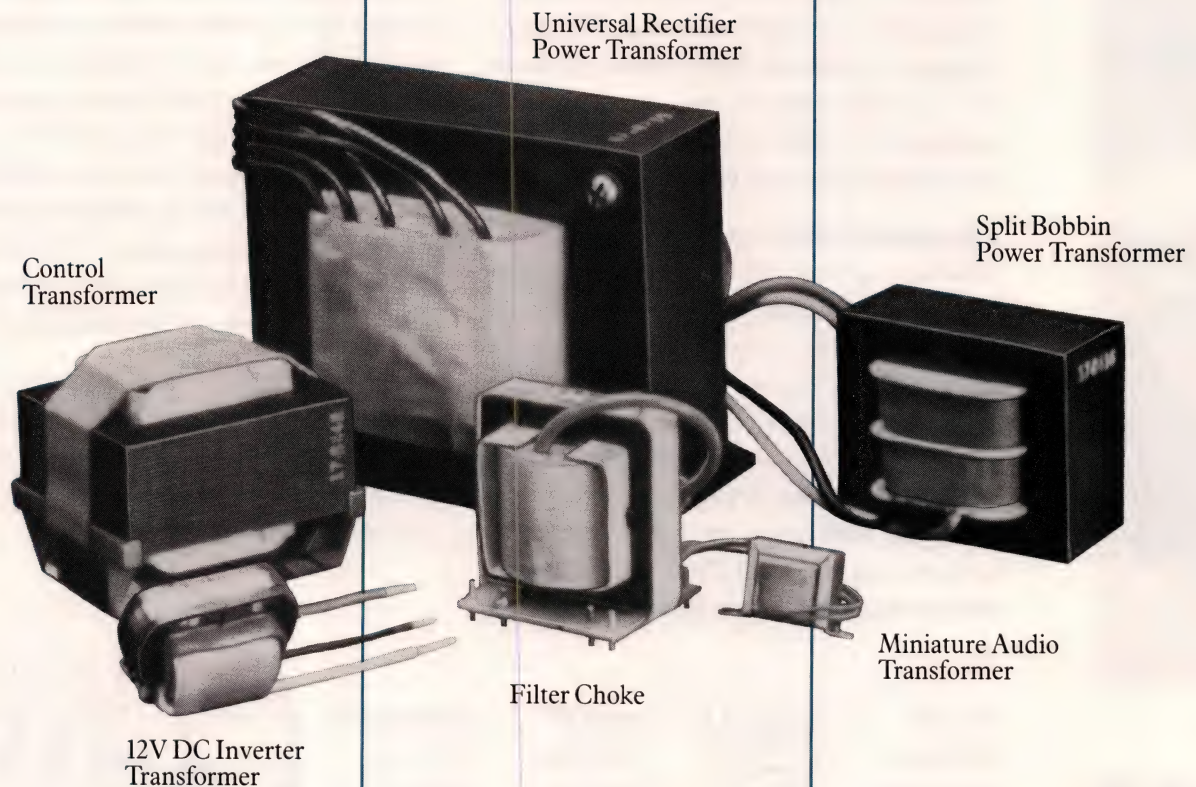
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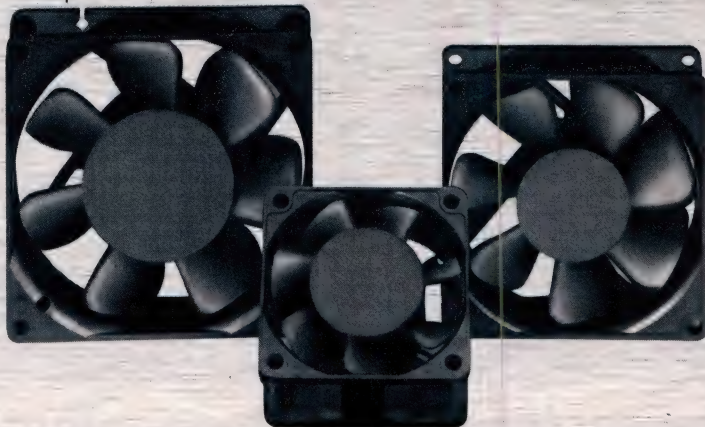
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CIRCLE NO 3

## DID YOU KNOW?

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## CALENDAR

**National Conference of Standards Laboratories (NCSL '89) Workshop and Symposium**, Denver, CO. Ken Armstrong, NCSL, 1800 30th St, Suite 305B, Boulder, CO 80301. (303) 440-3339. July 9 to 13.

**Quality Management Conference**, Denver, CO. Pam Frye, Quality Management Conference, ACEC, 1015 Fifteenth St NW, Washington, DC 20005. (202) 347-7474. July 12 to 14.

**Third International Workshop on Computer-Aided Software Engineering**, London, UK. John O Jenkins, Imperial College, School of Management, London, SW7 2PG, UK. 01 589 5111, ext 7112. Elliot J Chikofsky, Index Technology Corp, 1 Main St, Cambridge, MA 02142. (617) 494-8200, ext 1989. July 17 to 21.

**Computer-Aided Software Engineering, Hands-On** (short course), Washington, DC. John Valenti, Integrated Computer Systems, 5800 Hannum Ave, Culver City, CA 90231. (800) 421-8166; in Canada, (800) 267-7014. July 18 to 21.

**Network Cabling and Wiring Techniques** (short course), Washington, DC. John Valenti, Integrated Computer Systems, 5800 Hannum Ave, Culver City, CA 90231. (800) 421-8166; in Canada, (800) 267-7014. July 19 to 21.

**SparcIntosh** (conference), San Francisco, CA. Corey Green, The Yankee Group, 200 Portland St, Boston, MA 02114. (617) 367-1000. July 25 to 26.

**Supercomputers, Hypercubes and High Performance Architectures** (short course), Boston, MA. John Valenti, Integrated Computer Systems, 5800 Hannum Ave, Culver City, CA 90231. (800) 421-8166; in Canada, (800) 267-7014. July 25 to 28.



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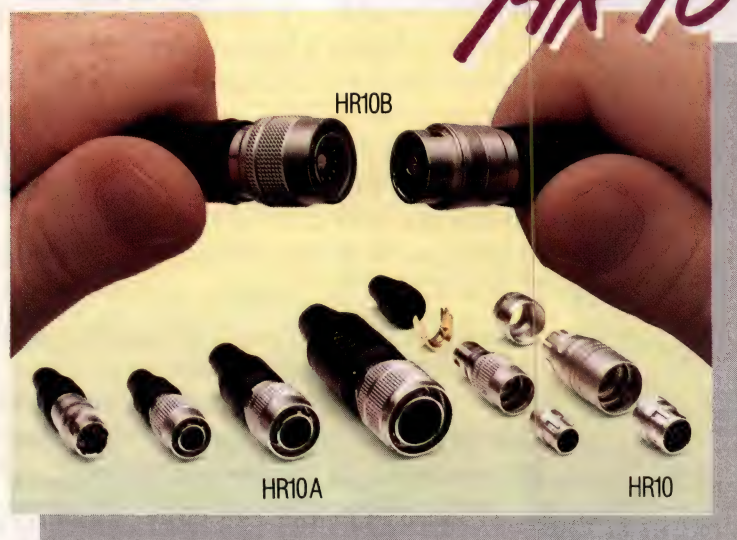
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CIRCLE NO 4

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## CALENDAR

**Basic Integrated Circuit Technology Seminar**, Sunnyvale, CA. Integrated Circuit Engineering Corp, 15022 N 75th St, Scottsdale, AZ 85260. (602) 998-9780. FAX 602-948-1925. August 15.

**11th Quartz Devices Conference and Exhibition**, Kansas City, MO. Electronic Industries Association, 1722 Eye St NW, Washington, DC 20006. (202) 457-4981. August 28 to 31.

**Surface Mount '89**, San Jose, CA. MG Expositions Group, 1050 Commonwealth Ave, Boston, MA 02215. (800) 223-7126; in MA, (617) 232-3976. August 28 to 31.

**International Test Conference 1989**, Washington, DC. International Test Conference, Box 264, Mt Freedom, NJ 07970. (201) 895-5260. FAX 201-895-7265. August 29 to 31.

**Midcon/89**, Rosemont, IL. Midcon/89, 8110 Airport Blvd, Los Angeles, CA 90045. (213) 772-2965. September 12 to 14.

**Aerospace & Electronics '89** (conference), Santa Clara, CA. National Computer Graphics Association, 2722 Merrilee Dr, Suite 200, Fairfax, VA 22031. (703) 698-9600. FAX 703-560-2752. September 12 to 15.

**DISKCON**, San Jose, CA. Julie Sunseri, 710 Lakeway, Suite 170, Sunnyvale, CA 94086. (408) 720-9352. FAX 408-736-2523. September 26 to 27.

**IEEE International Conference on Computer Design (ICCD '89)**, Cambridge, MA. Giovanni De Micheli, Center for Integrated Systems, Room 129, Stanford University, Stanford, CA 94305. (415) 725-3632. October 2 to 4.



# Logic Simulation

## Q: Why simulate?

### A: To save time.

The ideal development cycle is schematic to prototype to production. Simulation dramatically decreases the dreaded loop of schematic to prototype to schematic to prototype to schematic to...

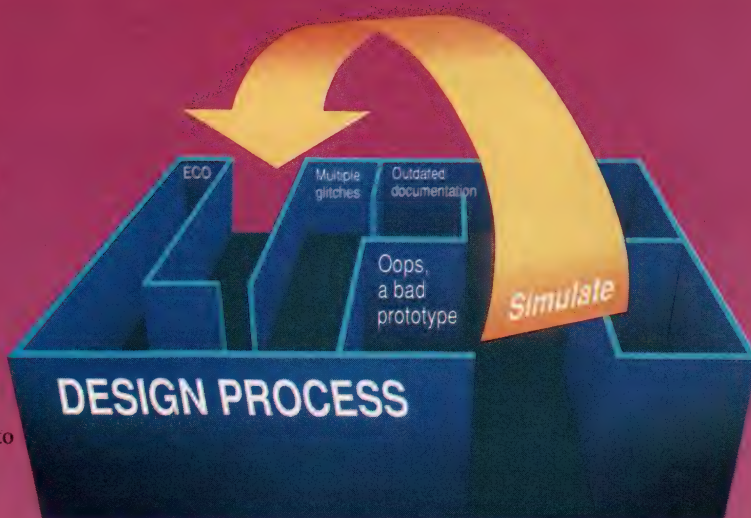
### A: To save money.

If your design goes through several iterations, is the documentation still accurate? Suddenly your time and budget are being spent on laying in patches, not producing.

### A: To make you look good.

Your schematic is supposed to be the best answer to someone else's design problem. Think of how great you'll look when you present a solution with no glitches, timing violations or other problems.

Verification of your design doesn't have to be handled at the prototype stage (or worse yet, the production stage).



You need a digital simulator that helps you find timing violations and design anomalies before you spend time and money on prototypes. The result: fewer iterations, a shorter design cycle, a more reliable product and getting the project right.

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**A: OrCAD/VST** enables you to interactively verify your design as it develops. A netlist from OrCAD's powerful Schematic Design Tools is all that's required to get started.

**A: OrCAD/VST** features a user interface similar to OrCAD/SDT III, including easy-to-use menu driven commands and powerful keyboard macros. Your valuable time is spent designing and testing rather than trying to learn a new system.

**A: OrCAD/MOD** extends OrCAD/VST to PLDs. A set of PLD Simulation Modeling Tools, OrCAD/MOD produces models of PLDs for OrCAD/VST to use in simulation of the larger circuit in which the PLD will operate.

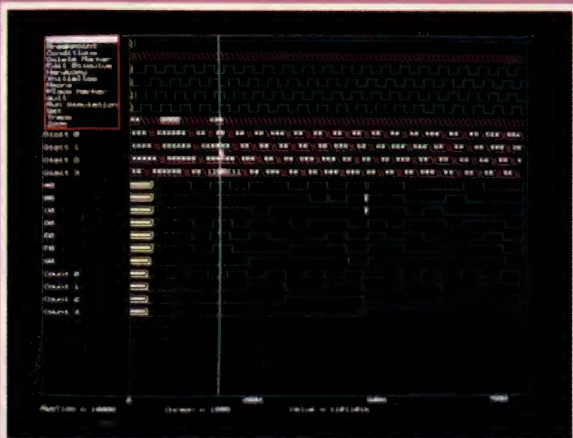
**A: OrCAD/VST** offers unsurpassed performance on a PC. Independent benchmark tests have hailed OrCAD's logic simulator as superior to other simulators costing 20 times as much.

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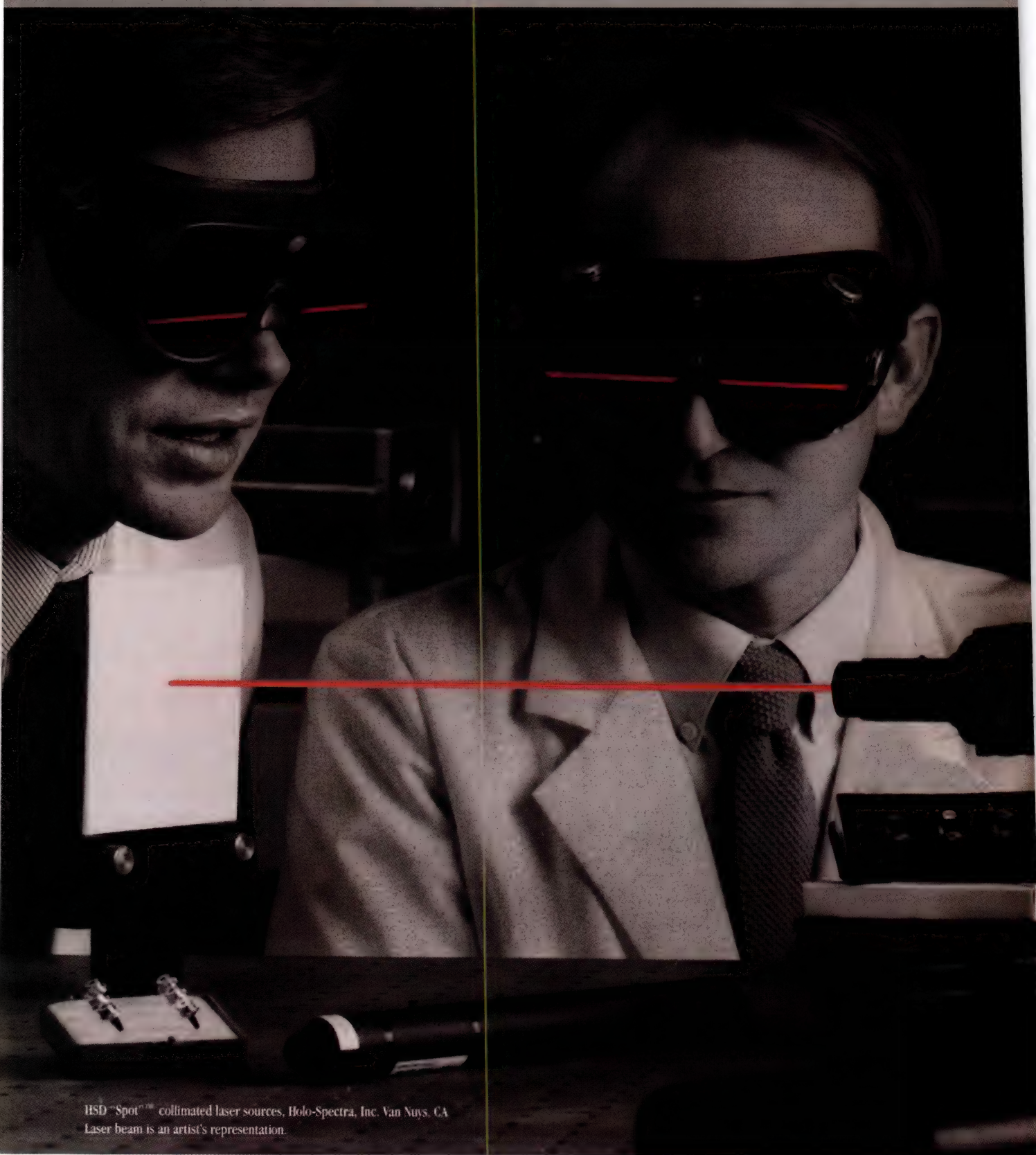
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# EDITORIAL

## Reward performance



Recently, *Business Week* published its list of the highest paid executives in the US. Some of the salaries and bonuses are exorbitant and far exceed the amounts that *stockholders* should be paying for the results these executives deliver. For example, Michael Eisner of Walt Disney Co received over \$40 million in salary and bonuses in 1988. On *Business Week's* list of those who gave shareholders the most for their pay, Eisner was second from the bottom. Overall, the average CEO's compensation rose by 17% in 1988, an increase over three times the 5% rise realized by middle managers and professional employees—such as engineers.

*Business Week* also shows that many top executives also received bountiful “golden parachutes,” which are those payments made to executives who bail out or are kicked out of a company after an acquisition or during a merger. F Ross Johnson, who left RJR Nabisco in February, received a golden-parachute package comprising cash, stock, and benefits valued at over \$53 million. There's no doubt that top executives should share in a company's good fortune and that their compensation should be tied to how well—or how poorly—their company does. However, stockholders should be asking themselves how much compensation is excessive.

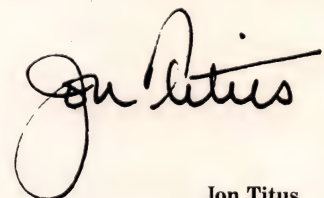
Employees are now asking if they shouldn't share in some of the wealth, too. Obviously a company's president, chief executive officer, and board of directors chart its direction, but managers, engineers, and production workers actually implement policies and are responsible for the success or failure of the course set at the top. These people, too, should share in the profits of success. The increasing pay disparity at the top, middle, and bottom of the company may soon lead to a backlash.

Chief executives may be the ones to decide whether or not to bet the company's future or a new product line or on a new marketing strategy, but the pressure on electronics engineers and their managers can be intense, too. Choosing the wrong microprocessor family or the wrong semiconductor technology can spell disaster for new-product developments and destroy a company's foray into a new product area. Engineers make such critical decisions every day. If stockholders are so willing to compensate those people at the top of the company, we think they should be willing to reward the engineers and other creative people who really make a company what it is.



Jesse H Neal  
Editorial Achievement Awards  
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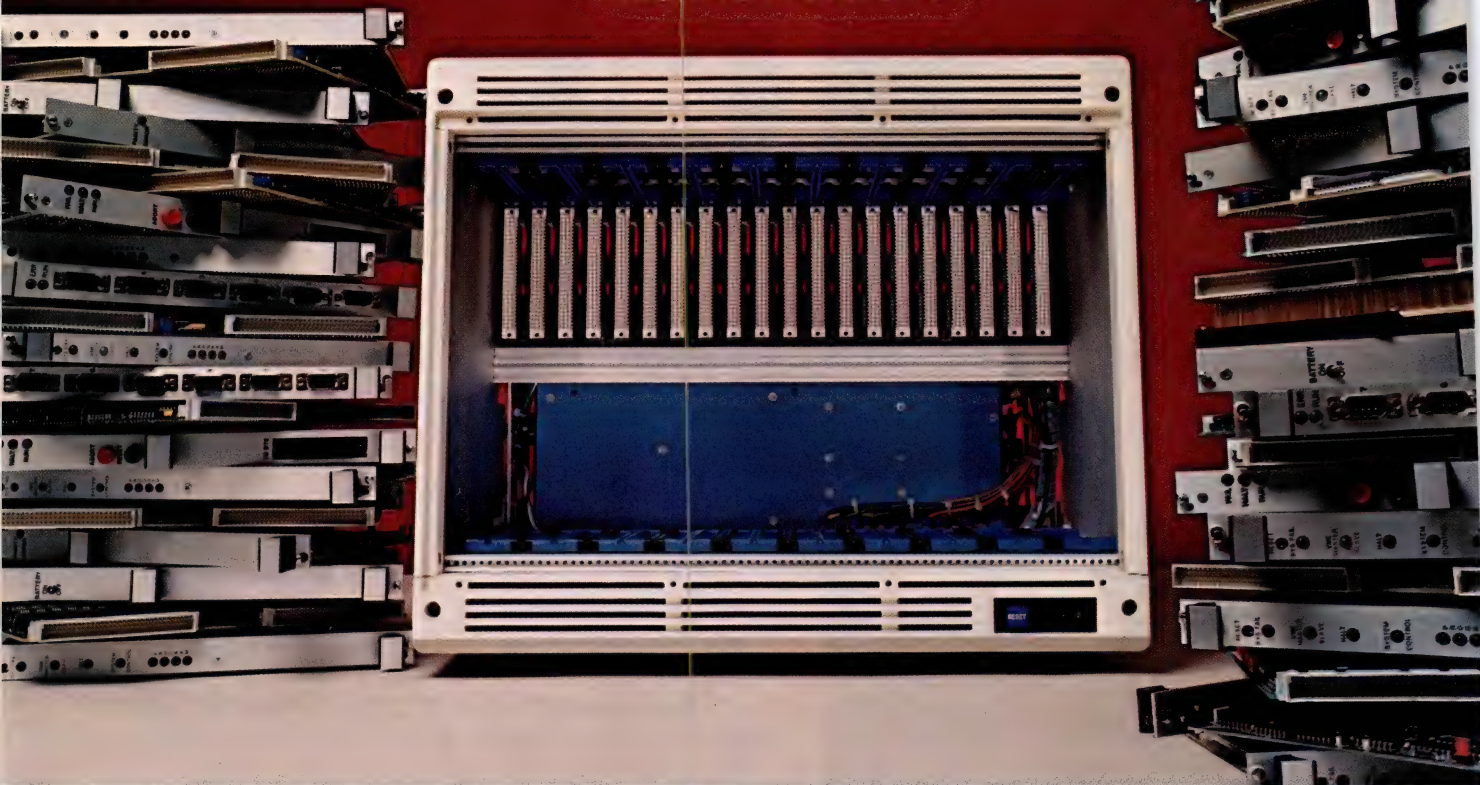
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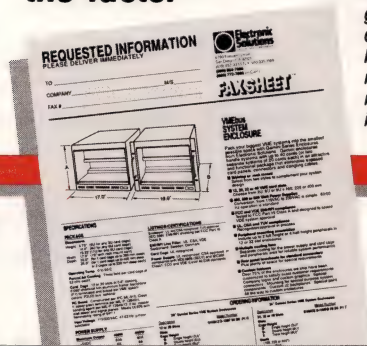
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The power-factor controller uses a current multiplier, operating with the line voltage and the error voltage as operands, to force the input-current waveform to match the input-voltage waveform. The device switches input current not required by the load into an external inductor, where the unused power is

stored in a magnetic field. The device can tap this field energy as needed to fill in when the input current is insufficient. The switching between energy sources allows the power-factor controller to maintain a steady 1A output at 380V dc.

Because the input current of the power-factor controller is sinusoidal, the power supply is prevented from introducing any noise back into the ac power source. In addition, the current multiplier is immune to the effects of ground noise. Both features aid in meeting strict European electromagnetic-interference limits for conducted emissions.

Another feature of the power-factor controller provides overvoltage protection to prevent output runaway when the load is removed. To simplify the start-up, the con-

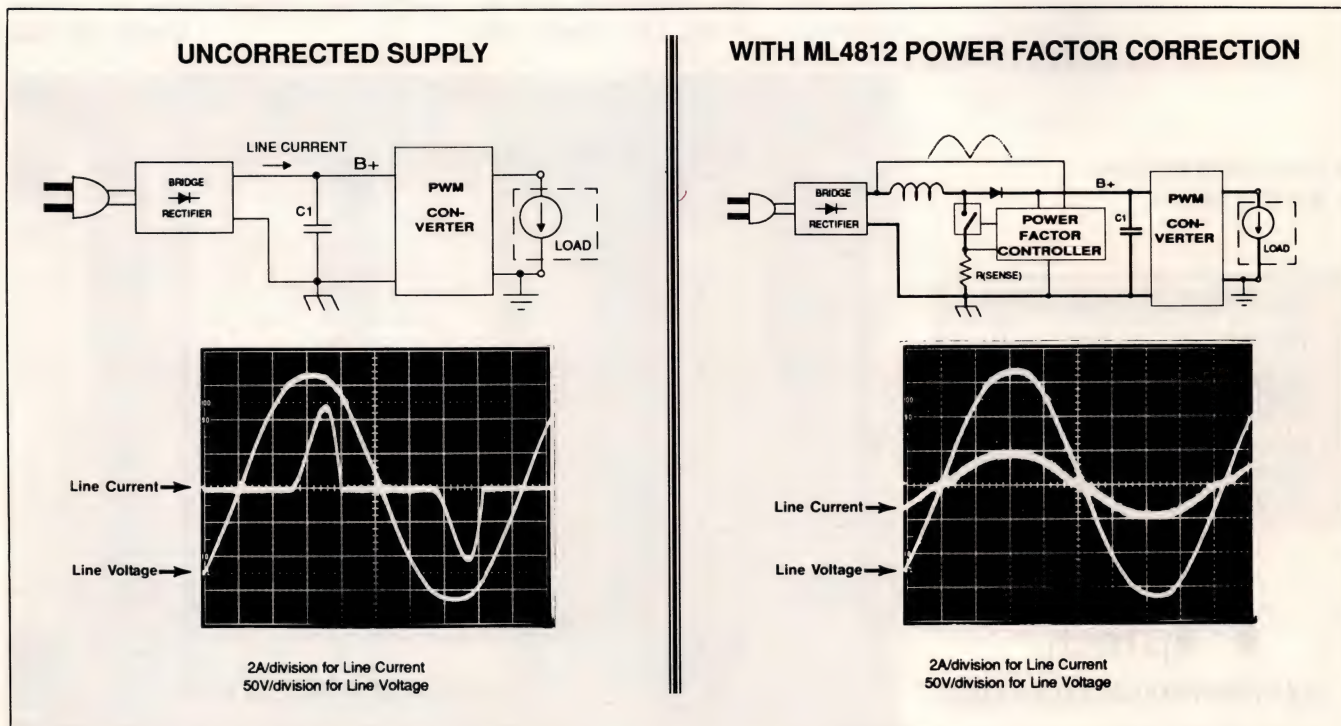
troller has an undervoltage lockout with 7V hysteresis. Furthermore, the ML4812 provides a 5V dc reference signal accurate to  $\pm 0.5\%$  and offers programmable ramp compensation that provides stability when the device's switching circuits exceed 50% duty cycle.

The ML4812 operates over an input-voltage range of 90 to 265V ac. This wide input-voltage range allows you to build a supply that operates at nearly any standard line voltage without needing jumpers or switches to reconfigure the supply. The device comes in either a 16-pin DIP or a 20-pin plastic chip carrier. The price is \$5.95 (100).

—Richard A Quinell

Micro Linear Corp, 2092 Concourse Dr, San Jose, CA 95131. Phone (408) 433-5200.

Circle No 433



Using the ML4812 power-factor controller in your power-supply design, you can utilize as much as 99% of the available power from your wall socket. The device forces the supply's input current to match the shape and phase of the input voltage.

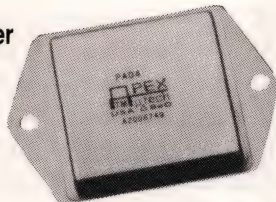


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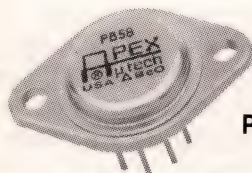
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# PRODUCT UPDATE

## ECL SPARC chip set operates at 80 MHz

The B5000 SPARC microprocessor is true to its ECL heritage. The 32-bit device operates with clocks as fast as 80 MHz and boasts a performance rating as high as 65 MIPS. Together with the B5100 floating-point controller, two B5210 register files, and the B5110/5120 floating-point chip set, the B5000 offers mainframe performance that fits into an office environment.

The B5000 chip set uses the standard SPARC binary interface but offers several enhancements, including a 5-stage pipeline, cache sizes to 512k bytes, instruction pre-fetch with a 4-word queue, and a double-word-wide interface between the processor and cache memory.

The extra-wide interface path allows the processor to fetch one of the following combinations: instructions and data together, two instructions, or two data words. The

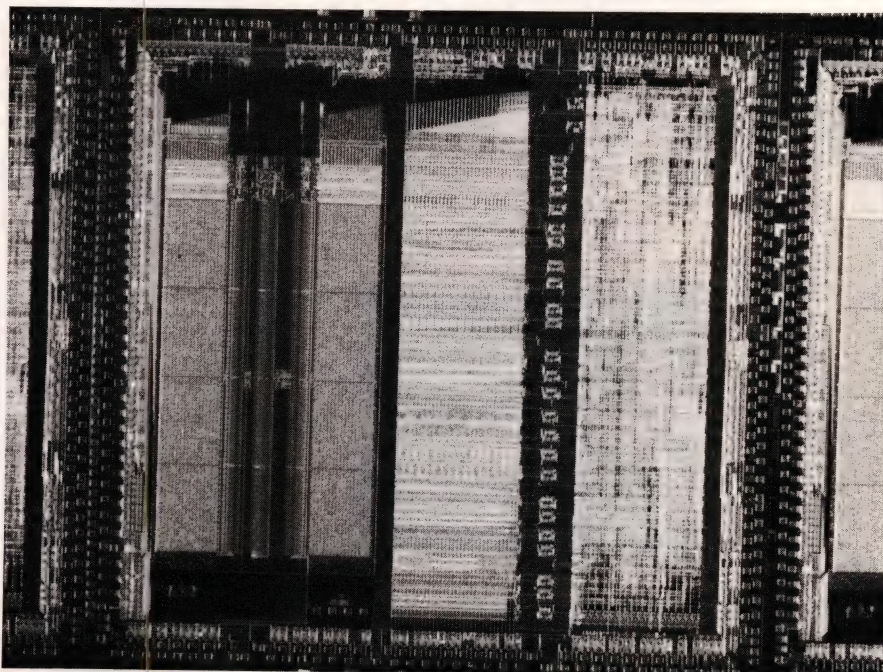
processor can fetch a branch instruction and its destination address in the same cycle, for example, or take in double-precision data in a single cycle. This flexible cache interface allows the B5000 to achieve 1.2 cycles per instruction.

The chip set also offers enhanced system integrity when used in a multitasking application. If a parity error is detected during operation, the system enters a synchronous trap. This function allows the operating system an opportunity to determine which process has suffered the error and to abort only that process. The system will continue to operate for the other processes.

The 6-chip set costs \$3300/set (100).—**Richard A Quinnell**

*Bipolar Integrated Technology Inc, 1050 NW Compton Dr, Beaverton, OR 97006. Phone (503) 629-5490. FAX 503-690-1498.*

Circle No 432



*This ECL SPARC microprocessor operates with clock rates as high as 80 MHz. The processor achieves 1.2 cycles per instruction and processing rates as high as 65 MIPS.*





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An abstract 3D composition featuring various geometric shapes like cubes and cylinders in shades of blue and gold. The shapes are arranged in a way that suggests movement and depth, with some elements appearing to be in the foreground and others receding into the background. Light trails and reflections are visible on the surfaces, adding a sense of dynamic energy.

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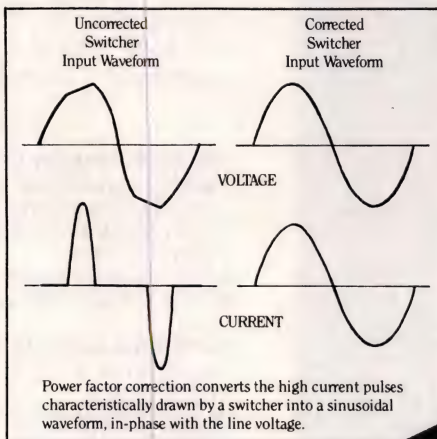
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# Modern dc power systems overcome component failures and ac outages

**Redundancy and the use of backup power supplies aren't just for military and aerospace applications anymore. Through these techniques, commercial electronic systems—such as computers and automatic test equipment—continue to perform under conditions that would have shut down older products.**

Dan Strassberg,  
Associate Editor

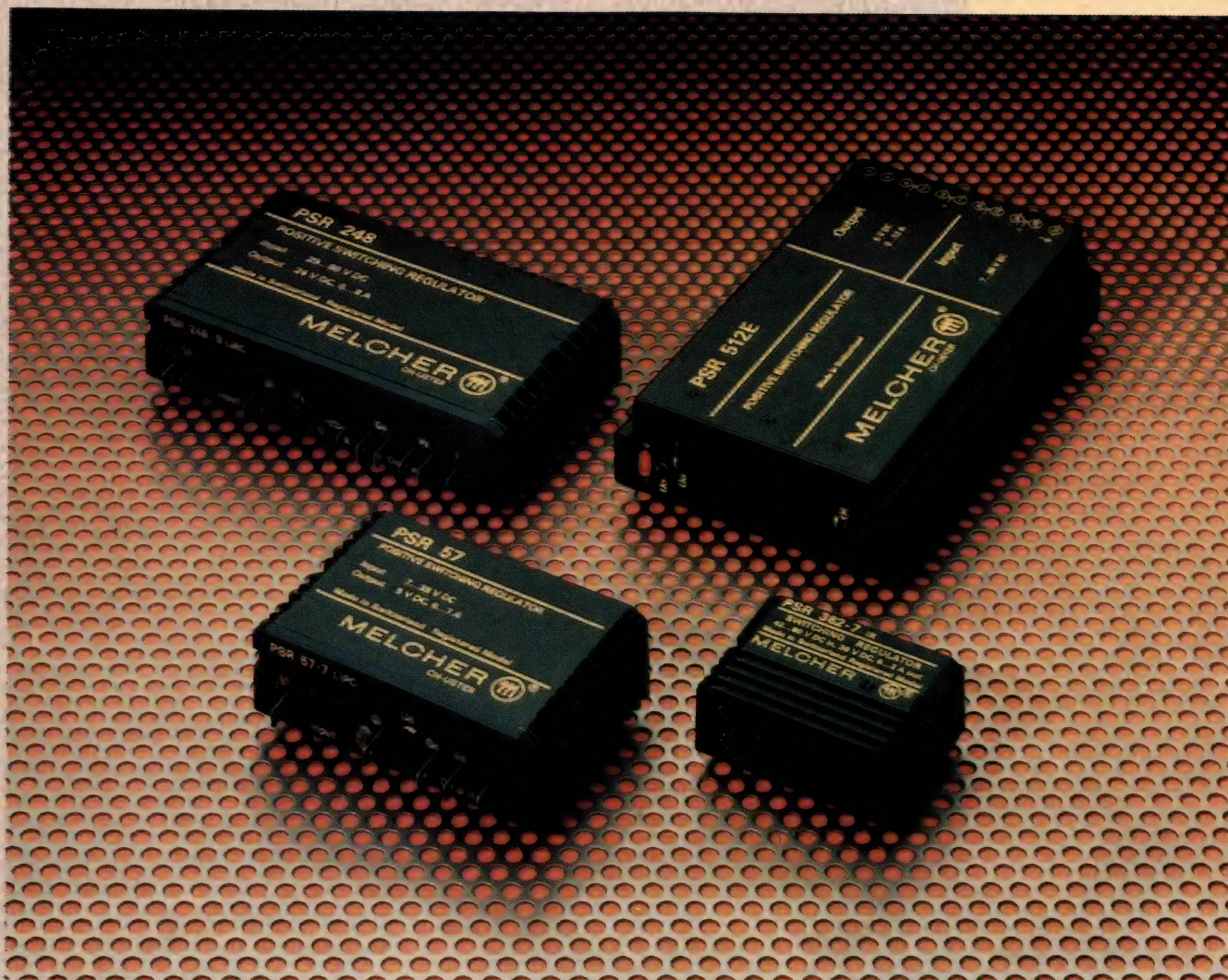
**Y**ou might think the electronic industry would have reached a consensus long ago on the most reliable and cost-effective approach to designing power systems for medium- and large-scale electronic products—such as workstations, supermini-computers, automatic test systems, and telecommunications equipment. But there is little agreement among power-system designers, even though their discipline is decades old. In fact, there are nearly as many design philosophies as there are designers and vendors—and the power-supply business is legendary for its large number of vendors.

Nevertheless, an approach that some vendors call “distributed power” is gaining adherents among

power-system designers. This scheme uses so-called “bulk” supplies to convert ac-line voltage to a dc voltage that is higher than that required by most of the circuits in the system. In systems that require immunity from short-duration ac power outages, batteries provide backup for the bulk supplies. To convert the bulk voltage to voltage levels the system components can use, dc/dc converters mount on or near the printed-circuit cards that contain the system's analog and digital circuits.

A second technique sometimes called “m-out-of-n redundancy” is often combined with distributed power. In systems that employ this redundant approach, the designers connect the outputs of n power sup-





plies in parallel—usually through isolation diodes. The system can derive all of its output power from  $m$  of these supplies, where  $m$  is smaller than  $n$  and is usually equal to  $n - 1$ . As many as  $n - m$  supplies can fail; in that event, the system issues a warning to the operator but continues to function as though nothing had gone wrong.

#### Life-cycle cost is lowest

Using distributed power and  $m$ -out-of- $n$  redundancy won't yield a system with the lowest possible initial cost, smallest size, or highest efficiency. Power-system designers who espouse these approaches argue, however, that the size and efficiency penalties are almost always unimportant, and that over its life,

a system that uses these techniques can cost considerably less than a comparable product designed with a classical dc power system. The reason for this lower life-cycle cost, they say, is that in a system that has a classical power architecture, failure of one supply usually puts the entire system "off the air." Down time of large systems can be extremely expensive, particularly in systems involved in a production process (for example, testing systems for pc boards or ICs). In systems used for on-line transaction processing—such as the computers used in stock exchanges and in tracking airline reservations—unscheduled down time incurs costs so large that nothing less than 100% availability is acceptable.

**DC/DC converters that maintain full ratings to 70°C (Melcher Inc)**



**Over its life, a system that uses redundancy can cost much less than a similar product designed with a classical dc power system.**

Bear in mind, though, that when you design a power system, it's very easy to wind up with a product that incurs all of the initial cost penalties associated with high reliability, yet is not reliable. You are most likely to run into this sad state of affairs if you adopt the classical attitude toward power-system design; that is, treating the power system as an afterthought, failing to allow enough time to evaluate vendors and products, and assuming that the job is so trivial that it doesn't require the effort of experienced, well-qualified personnel. In particular, if after completing a prototype,

power-supply business is extremely competitive, so you should be skeptical of any vendor that offers what seems to be a true equivalent to another company's product at a dramatically lower price. Although it isn't universally true, usually you get what you pay for. Investigate the two designs as thoroughly as you can by evaluating the performance of several units and by satisfying yourself that the supplies use truly equivalent components and construction. Look for evidence of vendors cutting corners to meet a price objective.

It also pays to be skeptical of MTBF (mean time between failures) figures. Many vendors refuse to publish MTBF estimates, though they will quote figures privately if you apply pressure. Here again, there is no unanimity among vendors. Some highly respected suppliers *do* publish MTBF estimates, but the majority of power-supply companies will tell you that MTBF calculations for non-MIL-spec power supplies have become a joke, and that for a power supply that uses commercial-grade components, you can calculate any MTBF that makes you feel happy. The reason for this situation is that MIL Handbook 217E, which forms the basis of the MTBF calculations, lists MTBF figures only for MIL-qualified components. Commercial power supplies don't use such components, so vendors must make assumptions about the reliability of the commercial components their supplies actually use. These assumptions can form the basis of exaggerated MTBF claims.

The MTBF figures derived from a vendor's warranty claims are also not good predictors of reliability. First of all, most supplies are installed in OEM equipment, so installing replacements for failed power supplies is not the power-supply vendor's responsibility. Replacing supplies may be the respon-



**Wide-input-range, pc-board-mounted, 15W dc/dc converters** (Computer Products/Stevens Arnold)

you abdicate responsibility for writing purchase specifications and qualifying alternate sources, turning the job over to someone whose only purpose is to find the lowest cost suppliers, you may end up turning a reliable design into an unreliable one.

More than 1000 vendors sell standard and semicustom power supplies in the United States. As you can well imagine, not one of these companies boasts that it provides *unreliable* power supplies. The

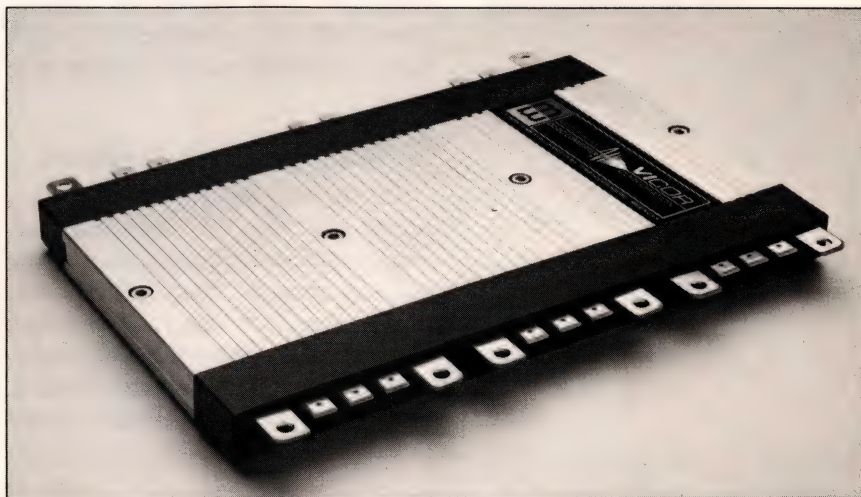


sibility of the system vendor's field-service organization, a third-party field-service organization, or the end user of the equipment. Consequently, most failed power supplies never find their way back to the supply vendor. Second, the power-supply vendor usually has no way of knowing about a failed supply's operating conditions or how much use the unit actually saw. A vendor can make wildly optimistic calculations of what's called "demonstrated MTBF" by assuming that every failed supply is returned, and that, since the original shipment to the system vendor, all of the failed supplies were run at 100% of their ratings 100% of the time.

### Electrolytics get a bad rap

In calculating a supply's MTBF, it's easy to assume that any supply that uses wet-electrolyte, aluminum electrolytic capacitors will be less reliable than an equivalent supply that does not use them. These capacitors are the only electronic (as opposed to electromechanical) power-supply components *known* to have a finite life. Indeed, some companies that make dc/dc converters without these capacitors claim the products have MTBFs in the neighborhood of 40 years. Competitors question the assumptions used in

the 40-year MTBF calculations, pointing out that even if you validate an MTBF value by running several hundred converters for a year, you can't predict what the failure experience will be over 40 years—nobody has manufactured



**High-power-density, triple-output dc/dc converter** (Vicor Corp)

such a product for more than about five years. Furthermore, the lifetime of a good-quality, wet-electrolyte, aluminum electrolytic capacitor is approximately 20 years, so it's not necessarily correct to assume that failures of such capacitors will represent the dominant failure mode in a supply that uses them.

Another point to consider when you evaluate published MTBF values is whether the supply in question incorporates a fan. In one technique that's sometimes used for calculating the MTBF of fan-cooled supplies, you exclude the fan from the calculation, because including it would produce an unacceptable MTBF estimate. The justification for the exclusion is that you should replace fans after approximately three or four years of continuous operation. If you replace the fans at this interval during scheduled maintenance, they won't fail and won't cause the supplies that use them to fail. Unfortunately, though, in some fan-cooled supplies, the fans are mounted in such a way that you must disassemble the en-



**Hermetically sealed, thick-film hybrid dc/dc converter** (Lambda Electronics)

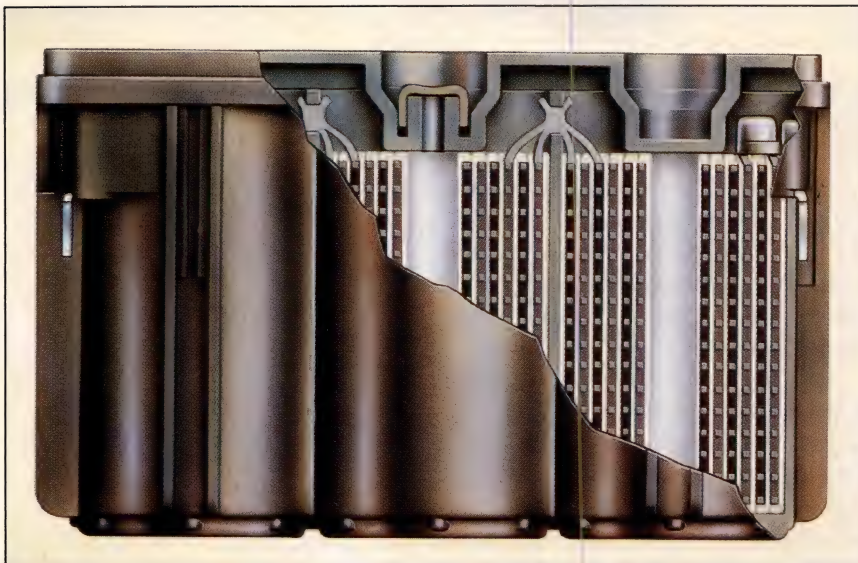


**In many transaction-processing systems, unscheduled down time incurs costs so large that nothing less than 100% availability is acceptable.**

tire supply to extricate the fan. Furthermore, unless you provide for easy fan replacement during your design process, you may have to disassemble your product substantially to get at the power supply. Such situations increase the likelihood that scheduled maintenance will not be performed or will cause problems rather than prevent them.

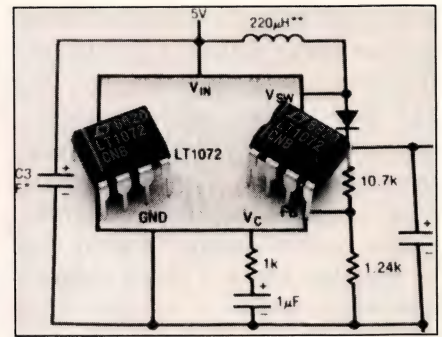
#### **Air filters can create problems**

If the supplies themselves don't incorporate fans, but the equipment does, and the equipment uses filters to keep airborne dust particles out, you can easily delude yourself about the system's potential reliability. Filters can quickly become clogged, and users of equipment are notori-



**Internal construction of a sealed lead-acid battery** (Gates Energy Products)

ously negligent about cleaning and replacing air filters. If the system continues to operate when the filters are clogged, and the power supplies are therefore forced to operate with significantly less airflow than the MTBF calculations assumed, the supplies will fail prematurely. Because of the possibility of failures associated with restricted airflow, you should consider using airflow sensors as well as fans with built-in rotation-speed sensors. By monitoring the sensor outputs, you



**Low-power, switched-capacitor IC dc/dc converters** (Linear Technology Corp)

can warn a system operator of trouble that will eventually disrupt the system's function.

You should also carefully consider the type of fans your system uses. Power-supply vendors generally agree that at the high temperatures frequently encountered in and around power supplies, ball-bearing fans are more reliable than those that use sleeve bearings.

Even if you design with heat sinks instead of fans, you can create reliability problems. The ratings of many pc-board-mounted dc/dc converters are based on case temperature. To operate such devices at more than a small fraction of their published ratings, you must either force a substantial amount of air past them or attach sizable heat sinks. The heat sinks' mass can create mechanical resonances that are stimulated by vibration during shipment. The result can be excessive physical stress on the components within the converter or on the points where the converter is soldered to the pc board on which you mount it. This stress can cause the converters to be "dead on arrival" or to fail prematurely. To prevent such problems, make the heat sink large enough to overhang the converter, and mechanically secure the heat sink to your board in addition to thermally coupling it to the converter.

Calculating MTBF values and keeping power supplies cool aren't the only controversial issues associ-

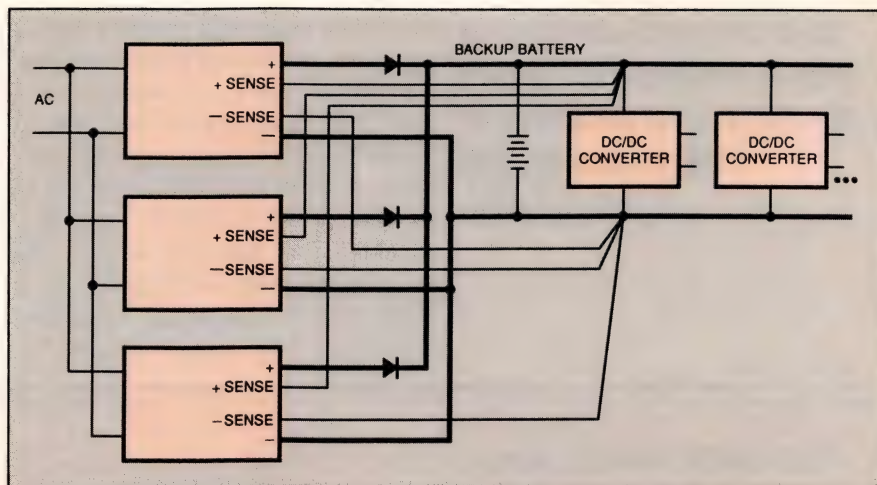


ated with power-supply reliability. Different vendors have different philosophies about how to connect the outputs of multiple supplies in parallel, but most vendors agree that, for maximum reliability, you should use isolation diodes as shown in Fig 1.

Today, most new system designs employ switching-regulated power supplies. The output stage of a switcher usually consists of a rectifier and a filter. When a rectifier fails, it usually behaves as a short circuit. Therefore, if you directly parallel the outputs of a number of switching supplies without using isolation diodes, and the output rectifier in one of the supplies fails in short-circuit mode, the entire group of supplies ceases to function. Nevertheless, isolation diodes exact a penalty on efficiency because they exhibit a forward voltage drop. The lower the supplies' output voltage, the greater the penalty on overall power-system efficiency. Some vendors incorporate the isolation diodes within their supplies; other vendors leave it to you to provide the diodes and an adequate heat sink for them.

#### Where to sense?

Some vendors recommend that you use remote sensing; that is, for a group of supplies that produce a positive voltage, you connect the positive sense terminals of all the paralleled supplies at a single point on the load side of the isolation diodes. Other vendors insist that remote sensing is likely to degrade the dynamic performance of the supplies to an unacceptable degree. These vendors recommend that you use local sensing—connecting each supply's sense terminals directly to its own output—on the supply side of the isolation diodes. Regardless of the sensing scheme, when you parallel supplies you must set each supply's current limit at or below the rated value. When the load is



light, the supply with the highest output voltage supplies the entire load until that supply reaches its current limit. At this point, the output voltage drops slightly, and the supply with the next highest output voltage assumes additional loads. This process continues until the load current reaches its maximum value. In a system with one more supply than is required to furnish the maximum load current, the supply with the lowest output voltage never provides any load current unless another supply fails.

In another scheme for paralleling supply outputs, used by Powertec, supplies operate in what the company refers to as "current mode." Each supply has a special terminal that you use when you connect the outputs of multiple supplies. A 1-wire "bus" interconnects this terminal on all supplies whose outputs are paralleled. The supplies need not have identical current ratings. The output voltage of the group equals that of the supply whose output is highest. All supplies in the group share the load in proportion to their ratings. Hence, if you parallel one 20A supply and two 10A units, and if the total load is 20A, the 20A unit will furnish 10A and each of the 10A-rated units will furnish 5A.

If your goal is 100% system availability, you need to decide whether

**Fig 1—A distributed power system** can consist of several redundant bulk supplies whose outputs are paralleled through isolation diodes and optionally backed up by batteries. In this configuration, the bulk supplies' force and sense terminals are connected near the load, which consists of dc/dc converters on or near the boards that contain the system logic.



**It is very easy to end up with a product that incurs the initial cost penalties of high reliability, yet is not reliable.**

you must make the power supplies replaceable without taking the system out of service. Designers *have* met this objective in commercial products, but if your system provides a warning and continues to function after a failure, you may conclude that you can achieve the required system availability at a lower cost by requiring scheduled shutdowns for power-supply re-

placement. Either way, you need supplies that individually provide a "power-good" indication. The indication should appear on the supply itself (probably in the form of an LED) to make it easier to spot a defective unit, and it should also appear as a logic level that the system can monitor.

If you plan to replace supplies with the system in service, you'll

## For more information . . .

For more information on power supplies, dc/dc converters, batteries, and high-current connectors such as those described in this article, circle the appropriate numbers on the Information Retrieval Service card or use EDN's Express Request service. When you contact any of the following vendors directly, please let them know you read about them in EDN.

Because there are so many vendors of products of the types described in this article, this list is by necessity only a partial one. A good place to start a search for additional vendors is in the advertisements in *EDN Magazine Edition* and *EDN News Edition*.

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probably want supplies that you can remotely shut down. You can obtain connectors from Elcon and Hypertronics that let you unplug a supply producing currents in excess of 100A—usually only if the output voltage is approximately 5V or less. However, the personnel replacing the supplies will be much less apprehensive if the supply is off when they unplug it. Simply placing a

switch in series with the ac line isn't a good way to shut down high-power supplies. A supply with a 1500W output operating at 80% efficiency and an 80% power factor from a 208V 60-Hz source draws an input current greater than 11A. It takes a fairly large switch to interrupt such a current in a 208V circuit repeatedly and reliably. Instead, many switching power supplies al-

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**MTBF calculations for non-MIL-spec power supplies have become a joke; for a supply that uses commercial components, you can calculate any MTBF value you wish.**

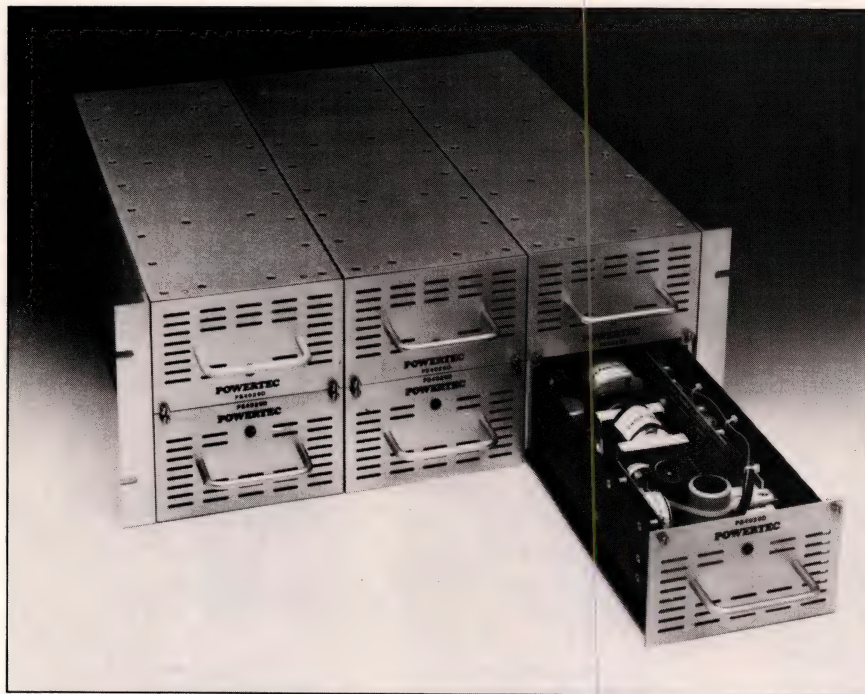
low you to use a logic-level signal to force a shutdown.

Supply-output wiring provides one of the few potential savings in the initial cost of distributed power systems. In systems made up of multiple cabinets, particularly those that use ECL, a major cost is the large bus bars and cables required to carry the output from supplies that produce hundreds of amperes at logic-supply voltages. The size of this wiring is determined by the allowable IR drop and the resulting voltage regulation at the point of load, not by the permissible  $I^2R$  losses. In a distributed power system, you send a substantially

of  $300 \div 55.7 = 5.38$ , but in fact, you can decrease the wire size by a much greater factor. First of all, the dc/dc converters can withstand a much wider input-voltage range *as a percentage of their nominal input voltage* than the logic can. Thus, at the expense of a small drop in efficiency, the wire cross-section can drop by a factor significantly larger than  $(28 \div 5.2)^2 = 29$ . Of course, you have to find a place to put the dc/dc converters. If you put them on the logic boards, either the board size must increase or fewer ICs will fit on each board. As an alternative, you can mount boards containing only dc/dc converters close to the logic. If you have modest power needs and don't need the transformer input-output isolation provided by many dc/dc converters, you can use switched-capacitor dc/dc converters, some of which are ICs packaged in 8-pin DIPs.

You can carry the use of high distribution voltages much further. Distributing a voltage higher than 28V allows still greater savings in wiring cost; indeed, several military airborne systems will use 270V dc, and telecommunications systems have long used a nominal 48V dc. However, choosing 28V dc or a value close to it lets you satisfy two requirements: First, safety agencies such as Underwriters Laboratories place a limit of 30V rms or 42.4V dc, the so-called SELV (safety extra-low voltage) limit, on the value of voltages accessible to service personnel who are not specially trained in high-voltage hazards. Once you've constrained the voltage to a value below 42.4V dc, your next problem is to select *the* value that gives you the widest possible selection of vendors and models. The distribution voltage that satisfies these two requirements is 28V or a value very close to it.

A 28V distribution voltage has further advantages if you need battery backup to ride through brief



**A redundant, fault-tolerant power system with hot plug-in capability (Powertec)**

higher voltage, generally 28V or more, to dc/dc converters on or near the pc boards that contain the system logic ICs.

#### **Distribute power to reduce wiring**

Suppose that instead of distributing 5.2V at 300A, you distribute 28V. To supply the same power, the current drops to only 55.7A. You might at first think you could decrease the cross-sectional area of the distribution wiring by a factor



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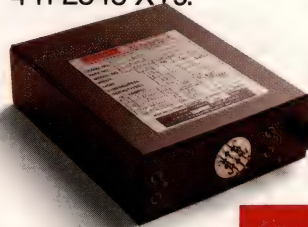
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**To minimize problems related to fans and clogged air filters, try using both airflow sensors and fans with built-in rotation-speed sensors.**

ac power outages. Lead-acid batteries are the most convenient type for standby applications (so-called "float-charge" service), because the primary alternative, nickel-cadmium (NiCd) batteries, require more elaborate charging circuits to deliver their potentially long life in float-charge service. On the other hand, in standby applications, you can simply connect lead-acid batteries in parallel with the output of your bulk supplies.

Although the precise value depends on the vendor, the optimum voltage for float charging a single 2V-nominal-voltage, lead-acid cell is approximately 2.35V. Thus the proper voltage for float charging batteries with a 24V nominal output is almost exactly 28V. You shouldn't use loosely regulated supplies to float charge the lead-acid batteries used for backup in elec-

charged and in good condition, a battery rated at 10 ampere-hours (10 Ahr) delivers at least 10 Ahr if the discharge current is  $^{10}/_{20}$ A (0.5A). For higher-rate discharges, you reduce the ampere-hour capacity. You can safely draw currents in excess of 50A from a lead-acid battery rated at 10 Ahr, depleting a fully charged battery in approximately three minutes. As the battery supplies energy to a load, its terminal voltage declines. If you use a 24V nominal battery voltage, you'll probably want to shut down the system when the battery voltage drops to approximately 20 or 21V. Below this point, drain on the battery causes a precipitous decline in its output voltage and possible damage to the battery itself. Most 28V-input dc/dc converters are designed with battery-backup applications in mind, so their input range usually includes 20 or 21V.

If a 10-Ahr battery has a nominal voltage of 24V at a current of 50A, it delivers in excess of 1 kW (but only about 50 watt-hours). You would construct such a battery by series connecting a pair of 12V batteries, each consisting internally of six 10-Ahr cells in series. Battery prices depend strongly on the quantity ordered, but in moderate quantity, you'll probably pay about \$30 each for 12V 10-Ahr batteries. Provided that the ambient temperature is not excessive, in float-charge service these batteries have a life expectancy of more than five years and require no maintenance. Some vendors say you can expect an 8-year battery life.

The shape of the bulk supply's V-I characteristic is an important consideration in selecting a bulk supply to use with backup batteries. It's very common for supplies to have "foldback" current limiting, as shown in Fig 2a. However, this characteristic is inappropriate when a supply is used with backup batteries. When ac power returns after



**Lead-acid batteries for constant-voltage charging** (Panasonic Industrial Co)

tronic equipment. Charging them to a lower voltage significantly diminishes the energy they store; charging them to a higher voltage for an extended period of time can damage them.

#### **C/20 is the key**

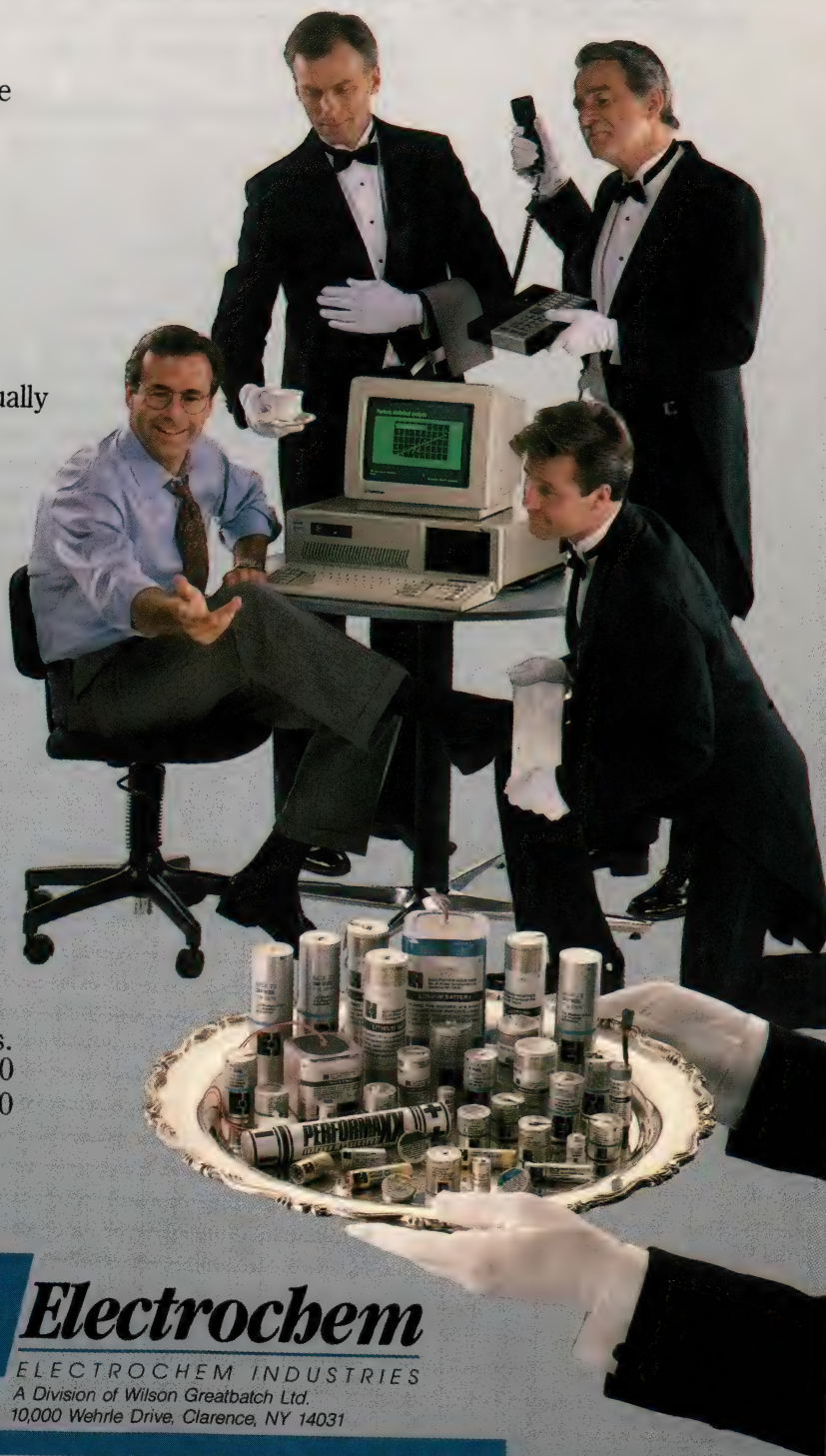
Vendors rate the capacity of lead-acid batteries at a so-called C/20 discharge rate. That is, when fully



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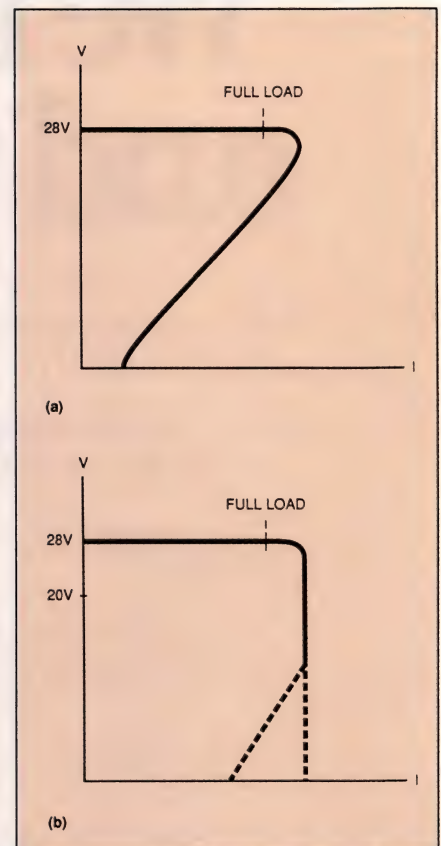
**Normally, when you parallel supplies, the supply with the lowest output voltage never supplies any load current unless another supply fails.**

an outage, if the bulk supply can't simultaneously charge the battery *and* power the load because of a foldback characteristic, you'll discover that the reliable power system you paid for isn't reliable after all. Instead, you should use a supply with a current-limiting characteristic like that shown in **Fig 2b**.

#### **New peripherals ease shutdowns**

If an ac power outage lasts so long that the system can't ride it through, the system's most important function during the outage is to save its status so that it can "return to the air" gracefully when power returns. A few years ago, systems that could benefit from high-reliability power subsystems usually used ac-powered, mass-storage peripherals (for example, hard disks and tape drives). Many systems still use such peripherals, but if the peripherals are to operate during an ac outage, an ac-in/ac-out uninterruptible power supply (UPS) must provide their power. Nowadays, however, large-capacity hard-disk drives are normally dc powered, so in a system that uses distributed power with battery backup, the disk drives can operate during an ac outage. Therefore, you won't have a big problem storing an image of several megabytes of dynamic RAM on the system's hard disk when ac power is off.

As mentioned earlier, redundancy and the use of both bulk supplies and dc/dc converters don't result in a power system with the lowest possible initial cost. Furthermore, the costs of properly designing a cooling system and system packaging for service accessibility further increase the initial cost of providing a reliable power system. Therefore, although power-supply vendors often quote prices below \$0.50/W for switching supplies, your *installed* cost for a distributed power system that employs redundancy will almost certainly exceed



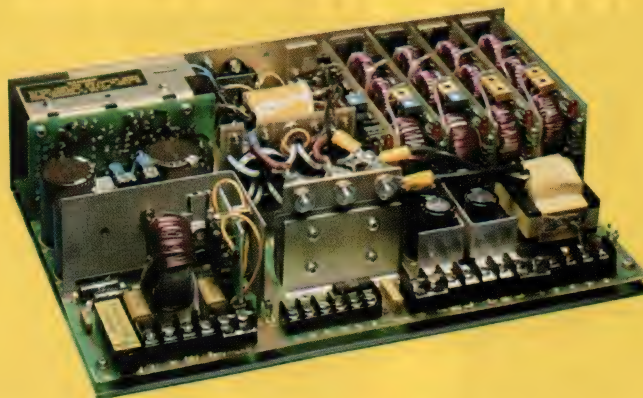
**Fig 2—A foldback output characteristic (a) doesn't work when your power supply must supply a load while simultaneously recharging backup batteries. A supply output that current limits, at least at voltages higher than that at which the system shuts down because of low battery voltage (b), is required so that the system will function when ac line voltage returns.**

\$1/W, and may easily be several times that figure. Nevertheless, in an era when field-service costs often run to hundreds of dollars per hour (if you include travel-related costs), and your customers' costs for a down system may represent thousands of dollars per hour, the added initial costs of providing a reliable power system seem small indeed. If you do the design job correctly, you can regard the initial cost as an investment that will produce an excellent return over the life of your product. **EDN**

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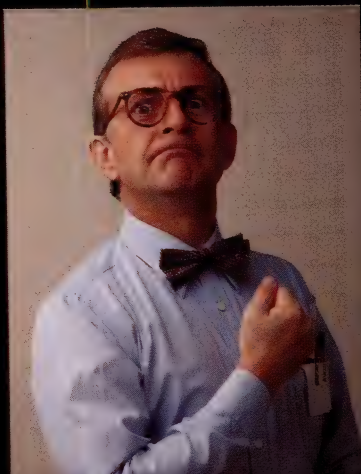
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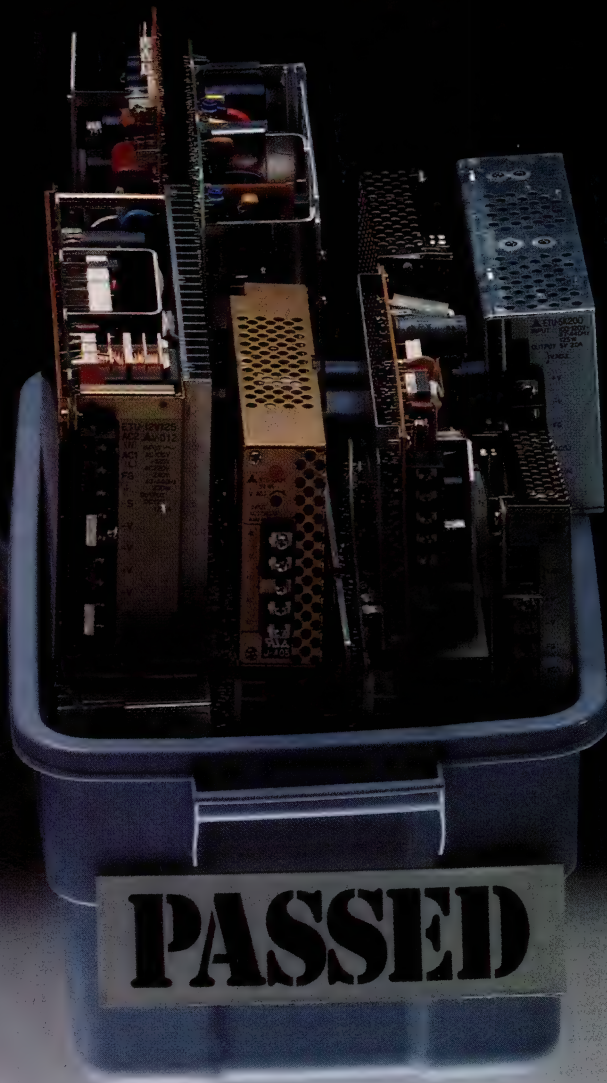
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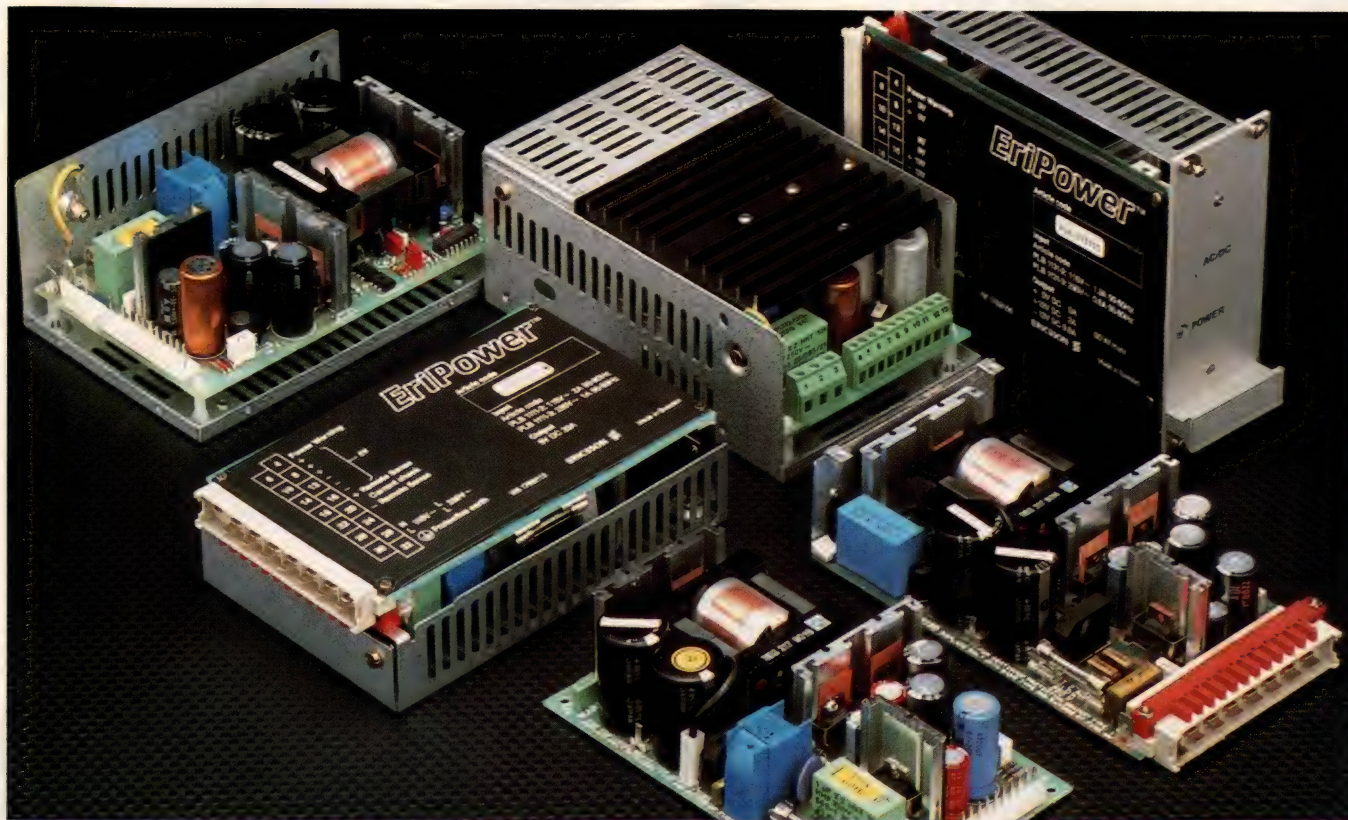
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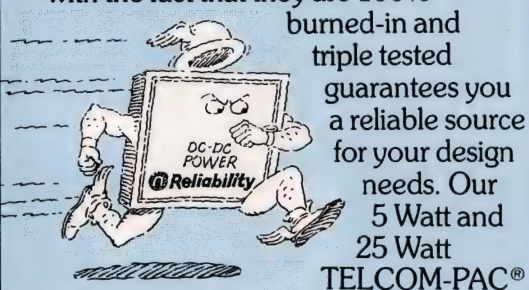
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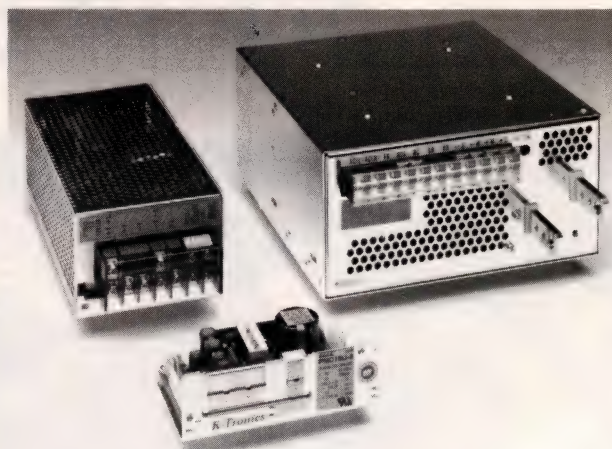
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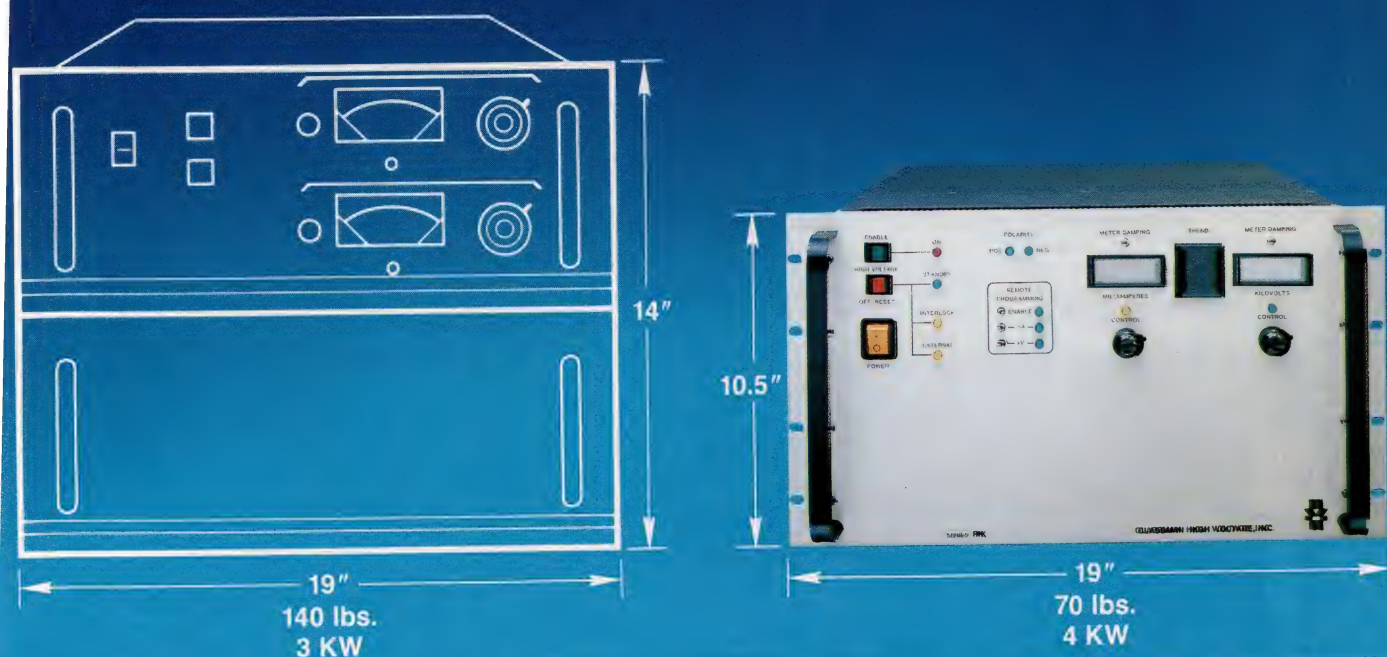


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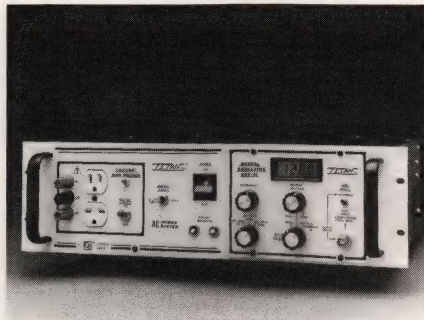


# Power Sources

## Wideband ac power sources deliver a 70 to 82% efficiency

The Titan Series of wideband ac power sources consists of the MAC-01, MAC-02, and MAC-03 mainframes, as well as the MOS-01 manual oscillator module and the EIM-01 external input module. By employing patented switch-mode, thick-film, power-hybrid circuitry, the sources realize a 70 to 82% power-transfer efficiency across the full output range. They can deliver a stable voltage and current output into any reactive load that has a leading or lagging power factor of 0 to 1.

The mainframes have output capabilities of 1000, 500, and 165 VA, respectively. They have both a 0 to 130 and a 0 to 260V rms output range, which you select via the front-panel switch. The output currents for the two output ranges are 8 and 4, 4 and 2, and 1.4 and 0.7A for the MAC-01, MAC-02, and



MAC-03, respectively.

Although the mainframes' full-output range is 45 Hz to 15 kHz, their usable frequency range extends to 20 kHz. The units' harmonic distortion is <1% from 45 Hz to 3 kHz and <3% from 3 to 20 kHz. Their output noise is 60 dB below the full-rated output, and their gain stability is  $\pm 0.25\%$  over 72 hours when the line and load regulation and the temperature are constant.

The MOS-01 module plugs into the mainframes and serves as a general-purpose sine-wave oscillator and a digital-readout monitoring system. The module operates over a 20-Hz to 20-kHz frequency range in three switch-selectable, 1-decade scales—20 to 200 Hz, 0.2 to 2 kHz, and 2 to 20 kHz. The EIM-01 external input module safely isolates and inputs an external drive signal into the power mainframes.

The MAC-01, MAC-02, and MAC-03 come in gold, irridite-plated, steel main chassis and cost \$1950, \$1250, and \$889. The MOS-1 and EIM-01 modules are priced at \$349 and \$59, respectively. All items in the series include a 1-year warranty.

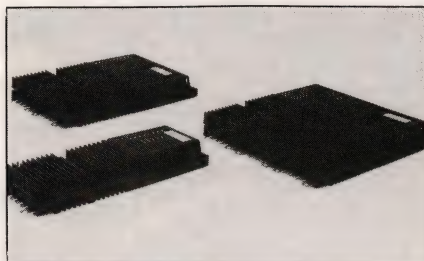
**Compact Power Co, 17282 Orange Dr, Yorba Linda, CA 92686. Phone (714) 996-5826.**

Circle No 439

## AC/DC switchers feature flat profile and pack 7W per cubic inch

The FlatPAC family of user-definable off-line switching power supplies includes single-, double-, and triple-output models. The units share a flat package profile—1.37-in. high by 8.6-in. long—and come in widths of 2.5, 4.9, and 7.4 in., which correspond to output power ratings of 200, 400, and 600W. In full-power configurations, the power density is 7W per cubic inch.

The standard output voltages are 5, 12, 15, 24, and 48V and are externally trimmable to +10% and -100%. The three different packages provide one, two, or three user-definable power cells. You can specify each power cell to be an in-



dependent isolated output with a power rating of 50, 75, 100, 150, or 200W, or you can combine the cells to form higher power outputs.

For example, you can configure a 3-cell, 600W unit as three totally isolated 200W outputs, or as two isolated outputs of 400W and 200W, or as a single output supply capable

of delivering 600W. Similarly, you can specify a 2-cell unit as either a single 400W supply or as a dual supply with 200W for each output. The single unit provides a single 200W output.

The units feature remote sensing and overvoltage and overcurrent protection. They also meet Class A interference specs, and conform to UL, CSA, and TUV safety requirements. In OEM quantities, the supplies are priced as low as \$0.85/W.

**Vicor Corp, 23 Frontage Rd, Andover, MA 01810. Phone (508) 470-2900. FAX 508-475-6715.**

Circle No 440



# Power Sources

## DC/DC converters feature 2:1 input range in 15 and 30W models

The Wide Range Series of dc/dc converters includes 26 models that feature input ranges of 9 to 18V or 18 to 36V at power ratings of either 15 or 30W. Single-, dual- and triple-output models are available in combinations of 5, 12, 15, -12, and -15V. The converters come in two packages, measuring  $3 \times 2.56 \times 0.83$  in. and  $4.56 \times 2.56 \times 0.83$  in.

The units operate at a switching frequency of 100 kHz, and their efficiencies range from 75 to 84%. The converters operate over a temperature range of  $-25$  to  $+71^\circ\text{C}$  without derating the outputs.

The converters' standard features include automatic voltage and current limiting on all outputs, a TTL-compatible control input for remote on/off control, input filtering, 6-sided shielding, and a mini-



imum isolation voltage of 500V dc. The 30W models also provide remote-sense inputs to compensate for lead-resistance voltage drops. Prices start at \$107.

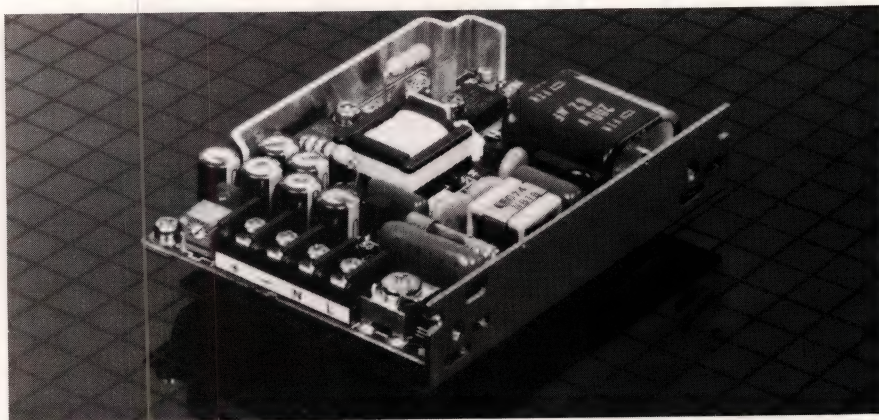
**Datel Inc, 11 Cabot Blvd, Mansfield, MA 02048. Phone (508) 339-3000. FAX 508-339-6356.**

Circle No 441

## AC/DC switchers deliver 15, 25, and 50W in slim package

The FAW International series and the FAK North American series of ac-to-dc switchers are available in three power levels: 15, 25 and 50W. The open-frame FAK supplies are 0.78 in. high; the optional-enclosure versions are 0.9 in. high. The widths of the FAK supplies range from 2.76 to 3.75 in.; the lengths range from 3.74 to 5.12 in. The International series features an input range of 85 to 264V and has UL, CSA, and TUV approvals; the North American series features an input range of 85 to 135V and has UL and CSA approvals. Four output voltages—5, 12, 15, and 24V—are available at each power level.

All of the units feature a power-OK LED, a soft-start circuit, and



a built-in EMI filter. The FAW models operate at 120 to 130 kHz, and the FAK models operate at frequencies as high as 260 kHz. Single-unit prices for the 15, 25, and 50W units are as follows: FAW series,

\$55, \$85, \$110; FAK series, \$55, \$75, \$85.

**Kepeco Inc, 131-38 Sanford Ave, Flushing, NY 11352. Phone (718) 461-7000. FAX 718-767-1102.**

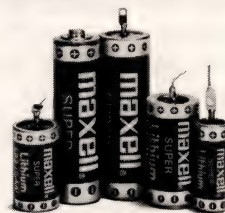
Circle No 442



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Component Program  
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## 220W switching power supply features low ac-line leakage

The MDT-224 is a standard quad-output, 220W switcher and meets the stringent requirements for medical electronics equipment. Specifically, the supply meets the UL554 and IEC601 specifications for patient monitoring equipment in a  $9 \times 5 \times 2.5$ -in. package. The MDT-224 provides 30A of 5V for logic and memory and peak currents as high as 12A for motor starting. The unit includes two auxiliary outputs of  $\pm 12V$  or  $\pm 15V$  at 1.5A.

To meet the medical-application requirements, the MDT-224 features low-leakage RFI filters and line-transient-suppression circuitry to survive the line-voltage transients found in hospital environments.

The user-selectable ac input is



either 90 to 132V ac or 180 to 264V ac at line frequencies of 47 to 63 Hz. The supply's line and load regulation is  $\pm 1\%$  over the ac input range and over a 0 to 100% load change. Ripple is less than 0.2% rms, and noise is either 1% p-p or 100 mV, whichever is greater. The output voltage returns to within 1% of its specified rating in less than

500  $\mu$ sec for a 50% load change. The peak transient does not exceed 5%. All outputs are protected against overload and short-circuit conditions; the supply recovers automatically upon removal of a fault. The overvoltage-protection trip point is factory set so that the 5V output can't exceed 6.8V. The supply's typical efficiency is 75%, and its MIL-HDBK-217 calculated MTBF is over 100,000 hours. The MDT-224 costs \$265 (100); delivery is six weeks ARO.

**Todd Products Corp, 50 Emjay Blvd, Brentwood, NY 11717. Phone (516) 231-3366. TWX 510-227-4905.**

Circle No 443

## Slim, uninterruptible power supplies protect personal-computer data

Designed specifically for personal computers, Power Cub power supplies provide immediate and complete protection of data from blackouts, brownouts, voltage transients, and noise interference. The units contain a battery-powered inverter that supplies electrical power to your system when utility power is not available.

The PC-300 has a power rating of 300 VA and provides 12 minutes of backup when under an average load and 29 minutes of backup under a half load. The PC-550 has a power rating of 550 VA and provides 10 minutes of backup under an average load and 15 minutes un-



der a half load. The transfer time from the ac line to the internal battery is 2 msec typ. The two models are housed in slim cabinets. The PC-300 measures  $16.54 \times 3.19 \times 14.96$  in.; the PC-550 measures

$16.54 \times 3.56 \times 17.25$  in. They weigh 30 and 36.4 lbs, respectively.

Individual power switches for all of the system's peripherals are mounted on the units' front panel for easy access. Other features include a front-panel lamp for keyboard illumination during power failure, LED indicators for mode operation, load-level and overload indicators, and telephone-line transient protection for modems. The PC-300 and PC-550 sell for \$609 and \$799, respectively.

**General Power Corp, Box 65008, Anaheim, CA 92805. Phone (800) 854-3469; in CA, (800) 824-8912.**

Circle No 444



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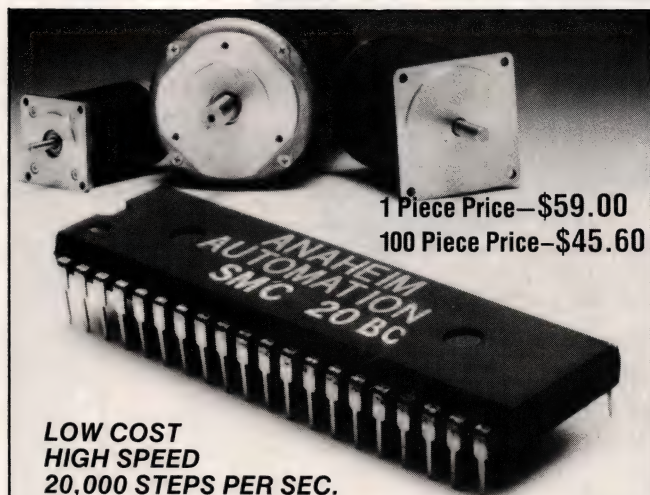
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121 New South Rd., Hicksville, NY 11801

CIRCLE NO 9



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New SMC20BC CMOS Step Motor Controller outputs a pulse signal for each step to be taken, and allows programming of direction, base and maximum rates, separate acceleration and deceleration slopes, and distance to be traveled in incremental or absolute position. • An internal buffer can be used to store command sequences for execution of routines on a stand alone basis. Limit switch, Jog and three programmable inputs and outputs are provided to make complex operations possible. The controller communicates through an 8-bit data bus in either ASCII or binary data formats.

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## POWER

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- Line operated supplies, Switching supplies
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# NEW SMD OUTLINE FROM PHILIPS. SOT-223...REAL 1W PERFORMANCE ON PRINTED CIRCUIT BOARDS!

Accepts extensive range of crystals up to 2.5mm square.

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Tab position leaves base free to be glued for wave soldering.

Dissipates a full 1W on printed circuit boards and 2W on ceramic substrates, without extra cooling.

An extensive range of crystals - rectifiers, diodes, thyristors, and both MOS and bipolar transistors up to 10 GHz can be put into the versatile SOT-223 outline. This feature, combined with the excellent heat dissipating property of SOT-223 means that you can now benefit from SMD technology in a wider range of applications.

But that's just the start. SOT-223 offers you power-*plus* an impressive list of board-mounting benefits.

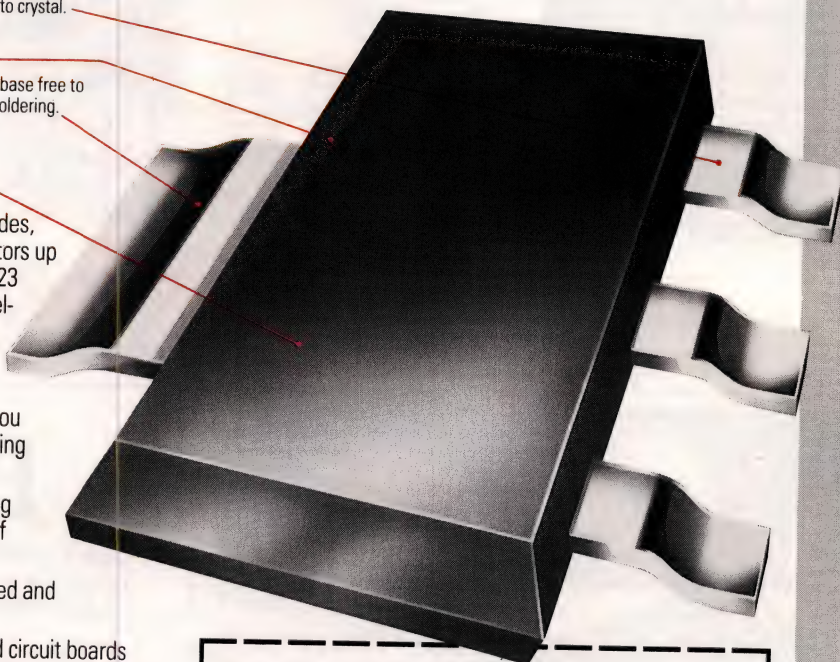
- Design ensures level mounting eliminating hot-spots, and also allows visual inspection of solder joints.
- Supplied on standard 12mm tape for speed and simplicity of automated placement.
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## Philips Components



# PHILIPS



# Power Sources

## DC/DC CONVERTER

The LT1026 dc/dc converter transforms a single-level input into a dual, higher-voltage output. The device uses bipolar switched-capacitor technology, negating the need for internal inductors. The converter has a 4 to 10V input range and will output voltages as high as  $\pm 18V$ . The maximum output current is 20 mA. The unit requires only 1- $\mu F$  charge pump capacitors. The converter comes in a plastic or ceramic DIP, a TO-5 metal can, and an 8-pin miniature DIP. An LT1026 in a miniature DIP, \$2.10 (100).

**Linear Technology Corp, 1630 McCarthy Blvd, Milpitas, CA 95035. Phone (408) 432-1900. FAX 408-434-0507.**

Circle No 526



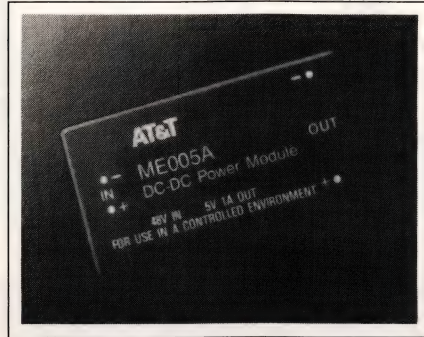
## 3-PHASE SWITCHERS

The Case 36 line of 3-phase-input switch-mode power supplies includes six different models with output voltages from 2 to 48V dc and power ratings as high as 3000W. Models are available with 2, 5, 12, 15, 24, and 48V outputs. All the models are powered from a 208V, 3-phase input with a frequency between 50 and 400 Hz. The Case 36 package measures 5 $\times$ 8 $\times$ 13.75 in. The line regulation is 1% with a 15% line change. The load regulation is 1% with the remote sense connected. A thermostat shuts down the power supply whenever the safe operating temperature is exceeded. Output inhibit, output current monitoring, dc

power good, and a reverse-air-flow fan connection are available as options. \$1895. Delivery, eight to 10 weeks ARO.

**Qualidyne Systems Inc, 3055 Del Sol Blvd, San Diego, CA 92154. Phone (619) 575-1100. FAX 619-429-1011.**

Circle No 527



## POWER MODULES

ME005A, ME005BK, and ME025ABK power modules operate from a nominal 48V dc input and meet FCC Class A requirements. The ME005A provides a regulated 5V output rating; the ME005BK module outputs  $\pm 12V$ . Both these models have a 5W power rating. Model 025ABK delivers 25W from three outputs—5 and  $\pm 12V$ . The ME005A and the ME005BK modules measure 2 $\times$ 1.1 $\times$ 0.46 in.; the dimensions of the ME025ABK are 4.26 $\times$ 2.58 $\times$ 0.5 in. ME005A, \$57; ME025ABK, \$162.34.

**AT&T Microelectronics, Dept 51AL230230, 555 Union Blvd, Allentown, PA 18103. Phone (800) 372-2447.**

Circle No 528

## UPSs

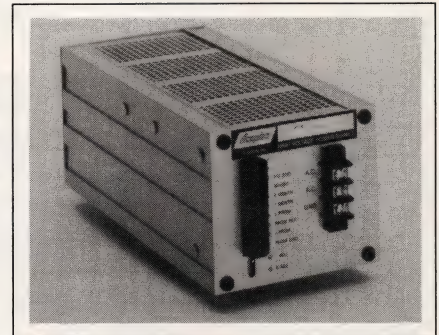
By utilizing thyristor switching techniques, the Power Lab H0 Series off-line uninterruptible power supplies can commutate between their line input supply and their internal lead-acid batteries in <10 nsec. This switching speed gives them a performance comparable to on-line uninterruptible supplies.

Targeted at users of personal computers and LANs, the series includes supplies with output ratings of 300, 600, 1000, and 1500 VA. They incorporate common-mode-rejection filters to smooth out harmonic fluctuations in the line input supply, and they provide full protection against voltage spikes, voltage sags and surges, brown-outs, and black-outs.

Depending on the connected load, the internal batteries provide between 10 and 30 minutes of back-up power. A software option, which operates under MS-DOS, provides an onscreen window that indicates line input interruptions and the amount of battery back-up time remaining. When only one minute of battery back-up remains, the software automatically closes and saves to disk any open files in the personal computer. £395 to £1200.

**Ondyne (UK) Ltd, Unit 4, Daventry Gate, W Portway Industrial Estate, Andover, Hampshire SP10 3SQ. Phone (0264) 66688. FAX 0264-66601.**

Circle No 529

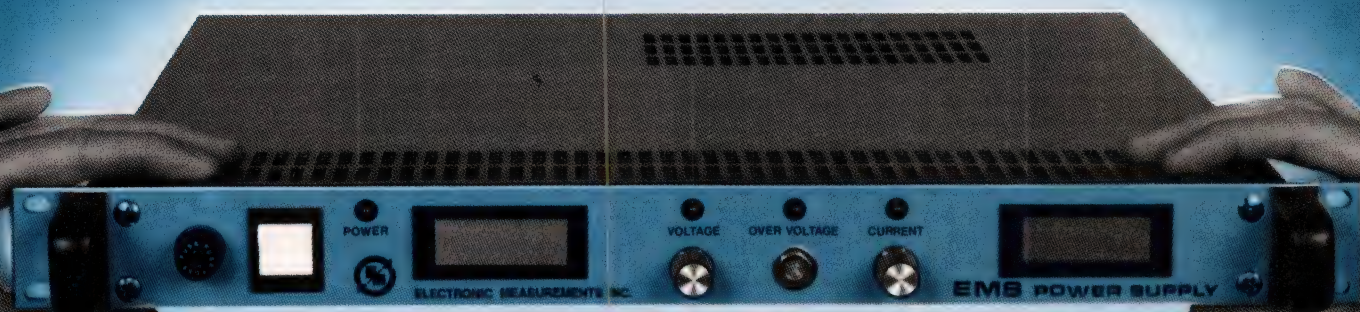


## POWER SUPPLIES

This line of high-voltage power supplies provides outputs with ranges from 0-1000V at 30 mA to 0-30,000V at 1 mA. Standard features include constant-voltage and constant-current crossover, a provision for output inhibiting and programming of both voltage and current, and arc/short-circuit protection. The line and load regulations are  $\pm 0.05\%$  each; ripple is 0.05% p-p. The ac-



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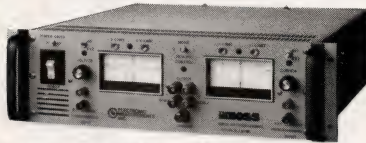




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**The BOSS™**

### BIPOLAR OPERATIONAL SOURCE-SINK



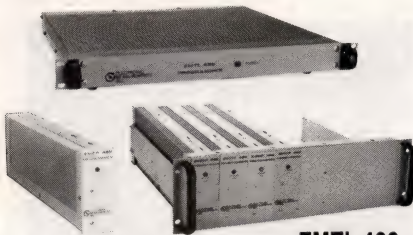
- 3 power levels 100 W to 200 W to 400 W
- 4 modes of operation: (1) bipolar power supply (2) an operational power supply (3) sourcing power supply (4) sinking power supply
- DC output voltages of  $\pm 20$  V DC through  $\pm 200$  V DC
- IEEE-488 or RS232 digital control
- Regulated and metered (V and A)

### ATR LINEAR DC POWER SUPPLIES



- 3 100 W  $\frac{1}{4}$  rack models
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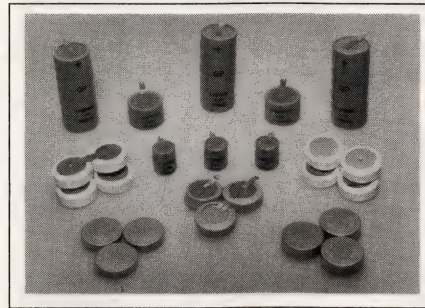
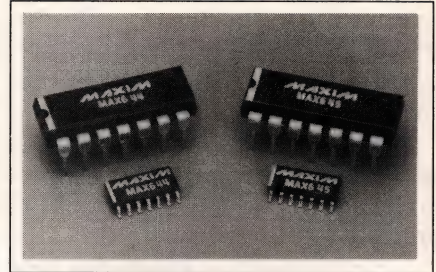
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## Power Sources

input supply can run from 105 to 125V or from 210 to 250V ac inputs. A dc-input unit can run from 21.6 to 32V dc inputs. The output connection is a flying lead. All other connections are on a pluggable terminal block. \$490 to \$890.

**Acopian, Box 638, Easton, PA 18044. Phone (800) 523-9478.**

**Circle No 530**



### NiCd BATTERIES

The PS-B60, PS-B100, PS-B170, and PS-B280 nickel cadmium button cells deliver 1.2V at 60, 100, 170, and 280 mAh, respectively. The batteries have a service life of 500 to 2000 charge/discharge cycles. At 20°C and after 12 months of storage, the cells retain 40% of their nominal capacity. You can purchase single cells, or you can configure multiple cells into stacks or nestle them side by side. The terminal options include pc-board-mount pins, solder tabs, and wire leads. \$0.85 to \$1.20 (100).

**Power-Sonic Corp, Box 5242, Redwood City, CA 94063. Phone (415) 364-5001. FAX 415-366-3662. TLX 348400.**

**Circle No 531**

### BOOST CONVERTERS

The MAX644 and MAX645 boost converters supply regulated 5V when the available input voltage is very low, such as 1.3V from a single-cell battery. The MAX644 is guaranteed to start up at 1.15V and to continue to operate below 1V as the battery discharges. The MAX645 is optimized for slightly

higher inputs, such as two alkaline cells or one lithium cell. The converters can supply 30 to 500 mA of output current, and the typical conversion efficiency is 80%.

A number of features that minimize external components in battery-powered applications include an 80- $\mu$ A quiescent-current standby mode in which the converters can still supply low currents; a battery comparator output that goes low when the input battery voltage drops below 1.15V; a control input that allows you to select either standby or high-power mode; and a power-ready output that goes high when the 5V output has reached its proper output level after power-up or termination of standby. The devices are available in both commercial- and military-temperature ranges. From \$3.34 (1000).

**Maxim Integrated Products, 120 San Gabriel Dr, Sunnyvale, CA 94086. Phone (408) 737-7600.**

**Circle No 532**

### DC/DC CONVERTER

Suitable for use in ISDN equipment, the 48 ITS 1-05-40-T dc/dc converter allows you to generate the 40V required for the ISDN S-bus, and the 5V supply required by interface logic, from the voltage on the ISDN U-bus. The converter's isolated 5V and 40V outputs can deliver an output power of 1W, and you can adjust the 40V output to provide higher or lower voltages if required. The units achieve a typical efficiency of 80% over their entire input voltage range and require no derating over their operating



# Power Sources

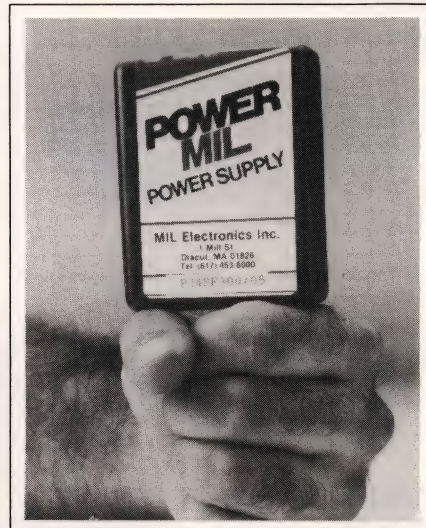
temperature range of  $-25$  to  $+71^{\circ}\text{C}$ . They are packaged in pc-board 40-pin DIP cases. SFr 85 (100).

**Melcher AG, Ackerstrasse 56, 8610 Uster, Switzerland. Phone (01) 944-8111. TLX 828554. FAX 01-940-9858.**

Circle No 533

## DC/DC CONVERTERS

Suited to high-energy applications, R-Series 15W dc/dc converters accept inputs of 10 to 40V dc. Single-output models provide from 30 to 1800V dc and dual-output versions generate outputs from  $\pm 15$  to  $\pm 900\text{V}$  dc. All units are housed in a  $2.5 \times 3.02$ -in. package that fea-

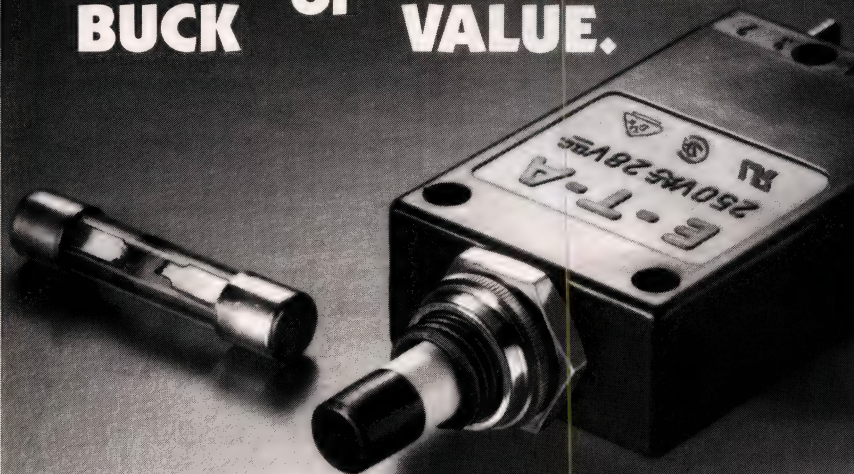


tures short-circuit protection. The converters have a built-in pi filter and a 75% typ efficiency rating. Switching frequency is 60 kHz and input-to-output isolation is equal to the output voltage plus 500V. Other specifications include a  $1 \times 10^9 \Omega$  min resistance, 50-pF I/O capacitance, and 3% line and load regulation. Single-output models, \$185 (100).

**MIL Electronics Inc, 1 Mill St, Dracut, MA 01826. Phone (508) 453-8000.**

Circle No 534

## FAST BUCK or LONG-TERM VALUE.



If your only concern is initial cost, then fuses cost less than E-T-A circuit breakers. But beyond initial cost, there's reality. Fuses *blow* and can drive up your cost of warranties, service, replacement, even product liability.

E-T-A circuit breakers, on the other hand, add value to your product. Yet they can lower costs while providing superior circuit protection and better performance characteristics than fuses. For example, they're trip-free, foolproof, 100% tested for quality, and approved for use, worldwide.

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# E-T-A<sup>®</sup>

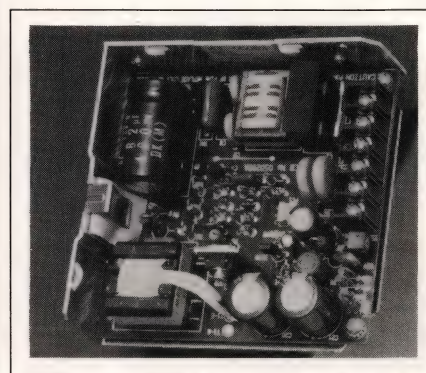
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CIRCLE NO 12



## SWITCHING SUPPLY

The MRE Series of 15 and 30W single-output switching power supplies accept any input voltage from 85 to 264V ac without the need for jumper wires or a switch. Supplies with output voltages of 5, 12, 15, and 24V are available. The units operate at switching frequencies of 50 to 300 kHz with typical efficiencies

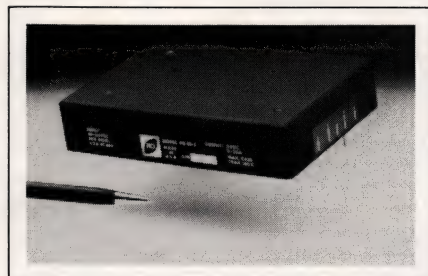


# Power Sources

of 70%. The line regulation is 0.4% max, and the load regulation is 0.8%, no load to full load. The units feature internal filters that meet the Class B EMI limits of FCC and VDE 0871. The supplies have UL, CSA, and TUV approval. The MRE 15 measures  $3.9 \times 3.86 \times 1.26$  in.; the MRE 30 is  $6.14 \times 3.86 \times 1.26$  in. MRE 15, \$28; MRE 30, \$43.

**Volgen America Inc, 39650 Liberty St, Fremont, CA 94538. Phone (415) 498-5950. FAX 415-498-5954.**

Circle No 535



## DC/DC CONVERTERS

Units in the RO Series single-output dc/dc converters can produce outputs of 125 to 150W at 20°C without the need for a heat sink or a fan. Housed in a  $0.98 \times 3.4 \times 4.85$ -in. package, the converters feature a 2.5°C/W case to ambient thermal resistance. Converter outputs equal 5V at 25A, 12V at 12A, 15V at 10A, 24V at 6A, and 28V at 5A. The converters feature true N+1 redundancy with current-sharing, paralleling, and hot plug-in capability. Nonshutdown overvoltage protection, logic on/off, short-circuit protection, and overtemperature protection are standard on all units. The converters comply with MIL STD 810D, UL, CSA, and VDE requirements. The converters operate with inputs of 36 to 66V in the RO 48 Series or 200 to 400V in the RO 300 Series. \$249. Delivery, stock to 60 days ARO.

**RO Associates Inc, 246 Caspian Dr, Sunnyvale, CA 94088. Phone (408) 744-1450. FAX 408-744-1521.**

Circle No 536

## POWER SUPPLIES

The NFS350 Series open-frame switchers accept any input voltage from 85 to 264V ac without the need for jumper wires or a switch. The NFS350-7625 model has outputs of 5.1,  $\pm 12$ , and a floating output that you can adjust from 4½ to 16½V and reference as either positive or

negative. A second model, the NFS350-7626, offers outputs of 5.1,  $\pm 12$ , and a floating output that you can adjust from 15 to 30V and reference as either positive or negative. Total output power at an ambient temperature of 50°C is 350W with forced-air cooling of 30 cfm. The supplies' typical efficiency is 70%.



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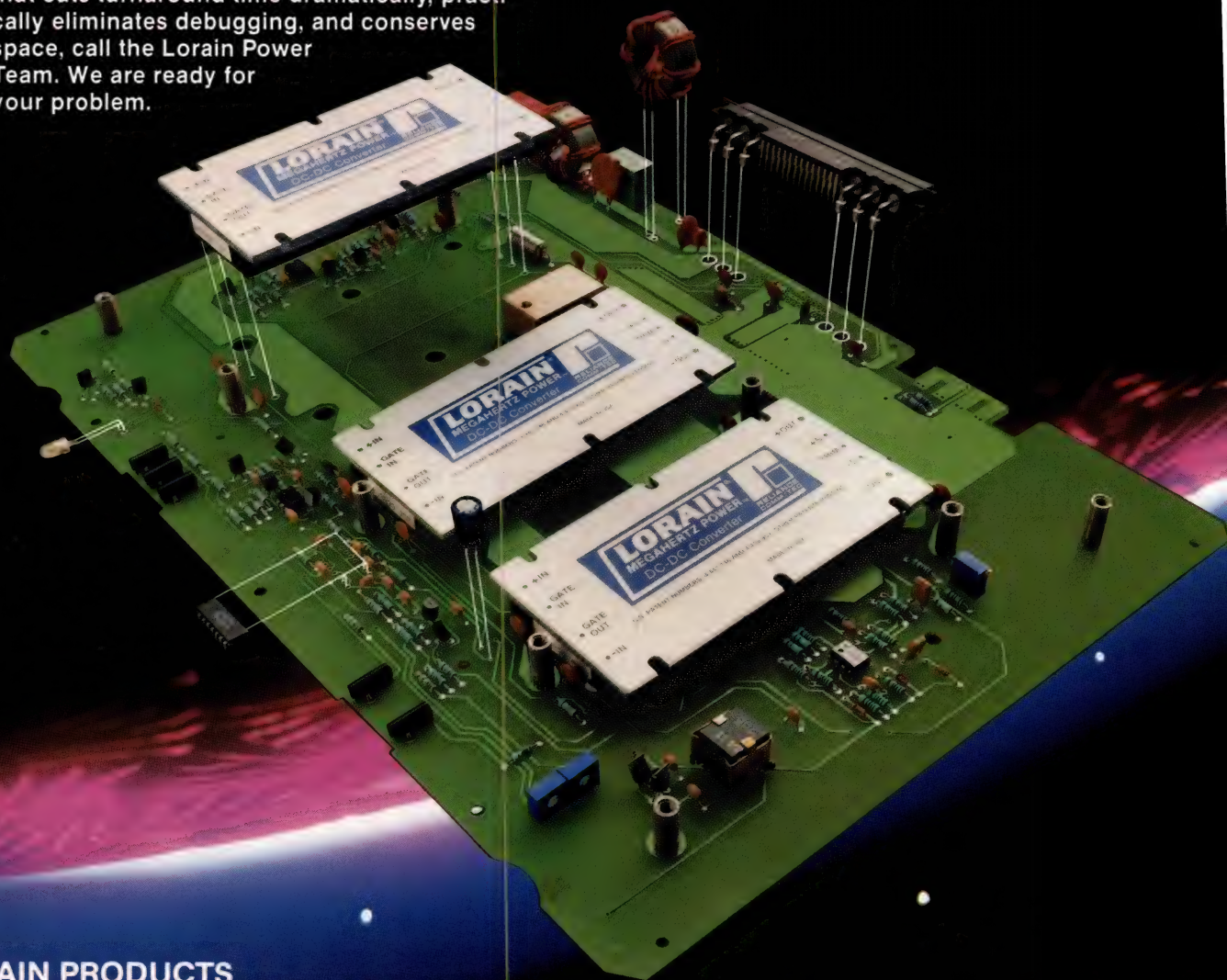
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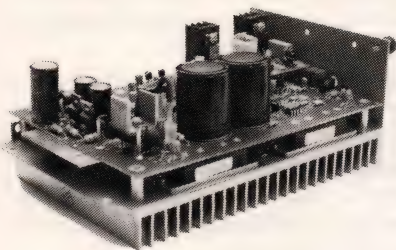
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**CIRCLE NO 14**

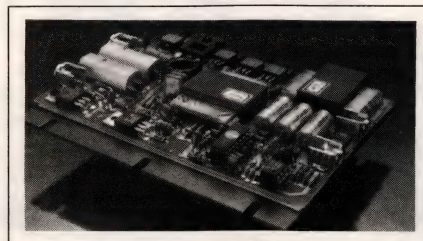
EDN July 6, 1989

## Power Sources

The NFS350 Series supplies are UL-, CSA-, and VDE-approved, and their built-in line filter reduces conducted noise below FCC limit B and VDE limit A. \$319 (100).

**Computer Products/Boschert,**  
3797 Spinnaker Ct, Fremont, CA  
94538. Phone (415) 657-6700.

**Circle No 537**



### CONVERTER KIT

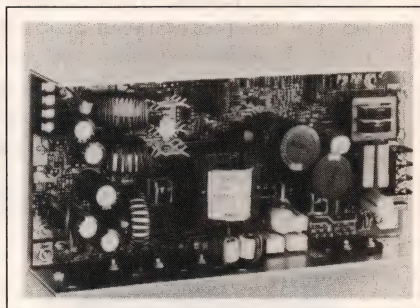
This kit enables designers to gain hands-on experience with resonant mode technology; it provides all the parts necessary to build a 5V, 20A resonant-mode dc/dc converter. The kit includes a pc board, a GP605 resonant mode controller IC, magnetics, power MOSFETS, all other necessary components, and a troubleshooting manual. The converter's performance features include a 36 to 60V dc input range, a switching frequency of 500 kHz, an efficiency of 80%, a line regulation of  $\pm 0.1\%$ , a load regulation of  $\pm 0.5\%$ , and an output ripple of 50 mV p-p. The unit measures  $5.25 \times 3.5 \times 0.625$ -in. \$150.

**Gennum Corp, Box 489, Station  
A, Burlington, Ontario, Canada  
L7R 3Y3. Phone (416) 632-2996.  
FAX 416-632-2055. TLX 0618525.**

**Circle No 538**

### POWER SUPPLIES

V225 and V325 quad-output switching power supplies have power ratings of 225 and 325W and provide main outputs of 5V at 30A and 5V at 45A, respectively. Specifications include an 80% efficiency rating, 1% or 100-mV p-p ripple and noise, and a 0 to 50°C operating range. Cooling requirements equal 30 cfm for V225



units and 60 cfm for V325 devices. All supplies feature a 20-msec holdup time and include overload, reverse voltage, and ac-undervoltage protection. Overvoltage protection is standard on the main outputs and optional on auxiliary outputs. Other options include power-fail monitoring, thermal shutdown, and logic inhibit. The supplies meet UL, CSA, IEC, and VDE safety standards and FCC/VDE emission requirements. V225, \$177; V325, \$231 (OEM qty).

**Deltron Inc, Box 1369, Wissahickon Ave, North Wales, PA  
19454. Phone (215) 699-9261. TWX  
510-661-8061.**

**Circle No 539**



### DC/DC CONVERTERS

Series 2100 20W dc/dc converters are available in single-, dual-, and triple-output versions. The units offer a  $13.3\text{W/in.}^3$  power density, an 87% efficiency, and 50-mV p-p output noise. Input-to-output isolation of 500V dc min allows the outputs to float with respect to the inputs.



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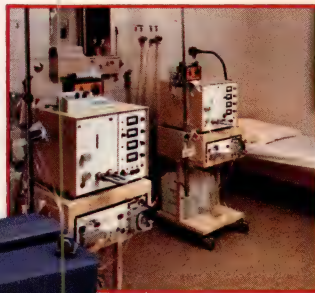
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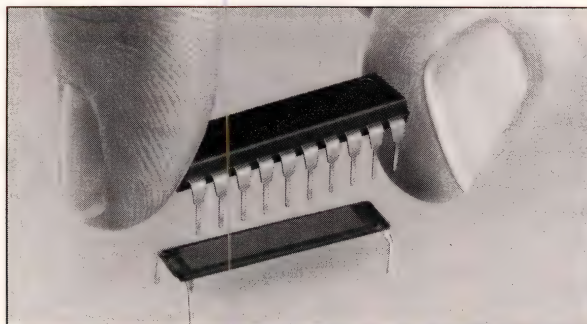
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CIRCLE NO 16



# Power Sources

Continuous 6-sided shielding minimizes EMI/RFI problems. Converters are available with input ranges of 9 to 18, 18 to 36, and 36 to 72V. Standard outputs are 5, 12, 15,  $\pm 12$ ,  $\pm 15$ ,  $5/\pm 12$ , and  $5/\pm 15V$ . Line regulation equals 0.5%; load regulation measures 0.2% for single-output models and 1% for dual-output versions. Operation range spans  $-25$  to  $+71^\circ C$ . From \$129.

**Conversion Devices Inc, 101 Tosca Dr, Stoughton, MA 02072. Phone (617) 341-3266.**

Circle No 540



## CRT SUPPLIES

L- and M-series CRT power supplies are available with positive or negative outputs in the range 1 to 30 kV; an optional first anode output is available, if required. All the outputs are protected against short circuits. The supplies require a 24V dc input. L-series units have an output ripple of 500 ppm maximum, and M-series supplies have an output ripple of 50 ppm. The M-series supplies also have a remote control option that allows you to control the output voltage with a 0 to 10V analog input. Linearity between the control input and the output is  $\pm 1\%$ . An optional adapter allows you to power the supplies from a line input. The series is available in commercial and military grade versions. L-series, £150 to £200; M-series, £190 to £340.

**Wallis Hivolt Ltd, Dominion Way, Worthing, West Sussex BN14 8NW, UK. Phone (0903) 211241. FAX 0903-208017.**

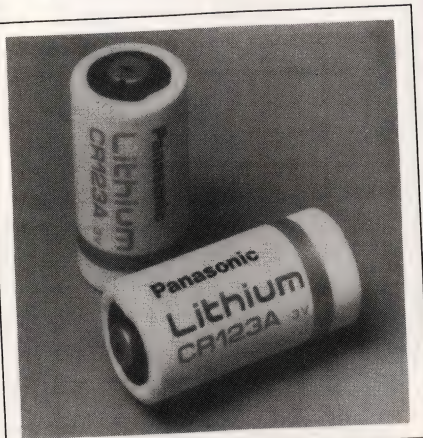
Circle No 541

## POWER SUPPLIES

Units in the 29D5 Series switching power supplies provide five isolated outputs ranging from 5 to 48V and a 300W total power rating at  $50^\circ C$ . The main output is rated for 5V at 40A. Outputs 2, 3, and 4 provide 12 or 15V at 3 or 5A. The semiregulated output 5 can be either 12, 24, or 48V at 6, 4, or 2A, respectively. Line regulation for the field-selectable 90 to 132V ac or 180 to 264V ac inputs equals 0.2%. Load regulation for inputs 1 through 4 also equals 0.2%. Output ripple and noise is 1% p-p. When equipped with an optional filter, the supplies meet the requirements of FCC 20780 Class A and VDE 0871 Class A EMI specifications. \$389.

**Powertec, 20550 Nordhoff St, Chatsworth, CA 91311. Phone (818) 882-0004. TLX 277483.**

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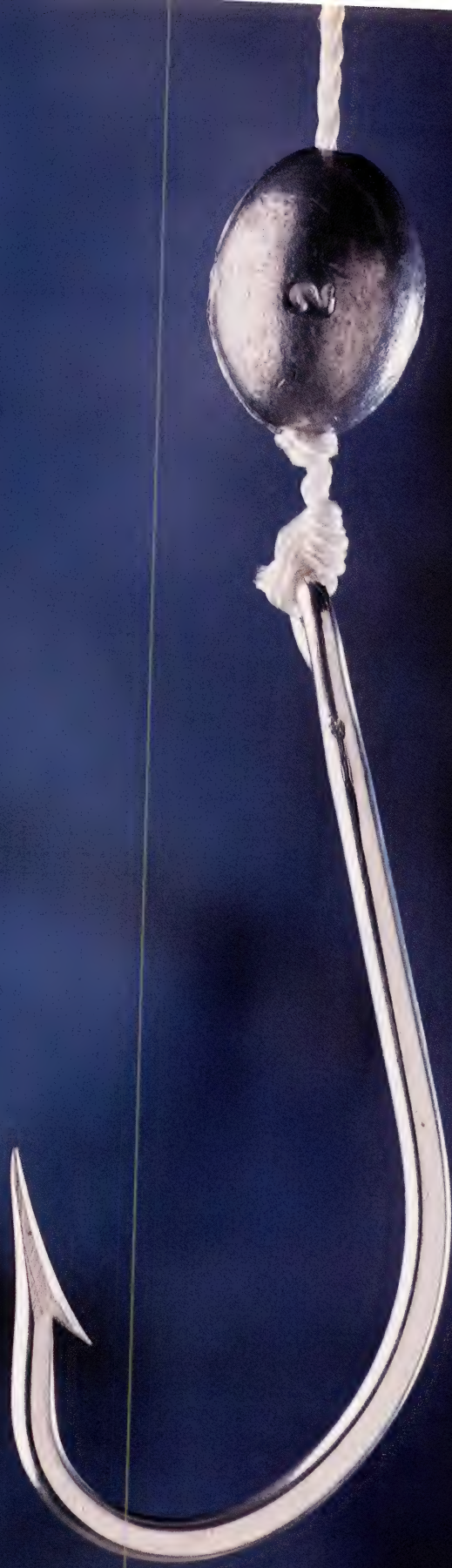
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CIRCLE NO 17







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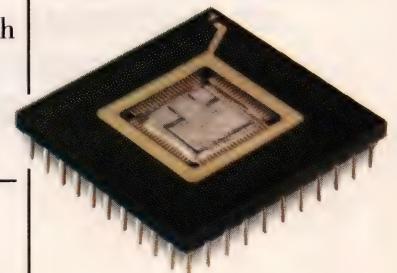
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# Specialized ICs drive flat-panel displays to new performance levels

**The recent improvements in the size and image quality of flat-panel displays are, in large measure, the result of improved manufacturing techniques and the use of better materials. No less important, however, is the contribution made by innovative IC drivers that bring new levels of performance to these increasingly popular displays.**

**T**he evolution of flat-panel displays from laboratory curiosities to the large-screen commercial products of today is inextricably related to the development of suitable integrated circuits. Rather than using hundreds—or even thousands—of discrete transistors in a bulky and costly configuration, today's displays are driven by a handful of dedicated ICs. Moreover, as designers of flat-panel displays respond to demands for improved performance, greater reliability, and lower cost, IC manufacturers are responding with sophisticated high-performance chips and innovative packaging.

Perhaps nowhere are the benefits of these newer chips more apparent than in those used for electroluminescent (EL) displays where symmetric row drivers and gray-scale drivers are improving reliability and performance. One of the most important developments is the availability of symmetric row-driver chips for use with ac thin-film EL displays.

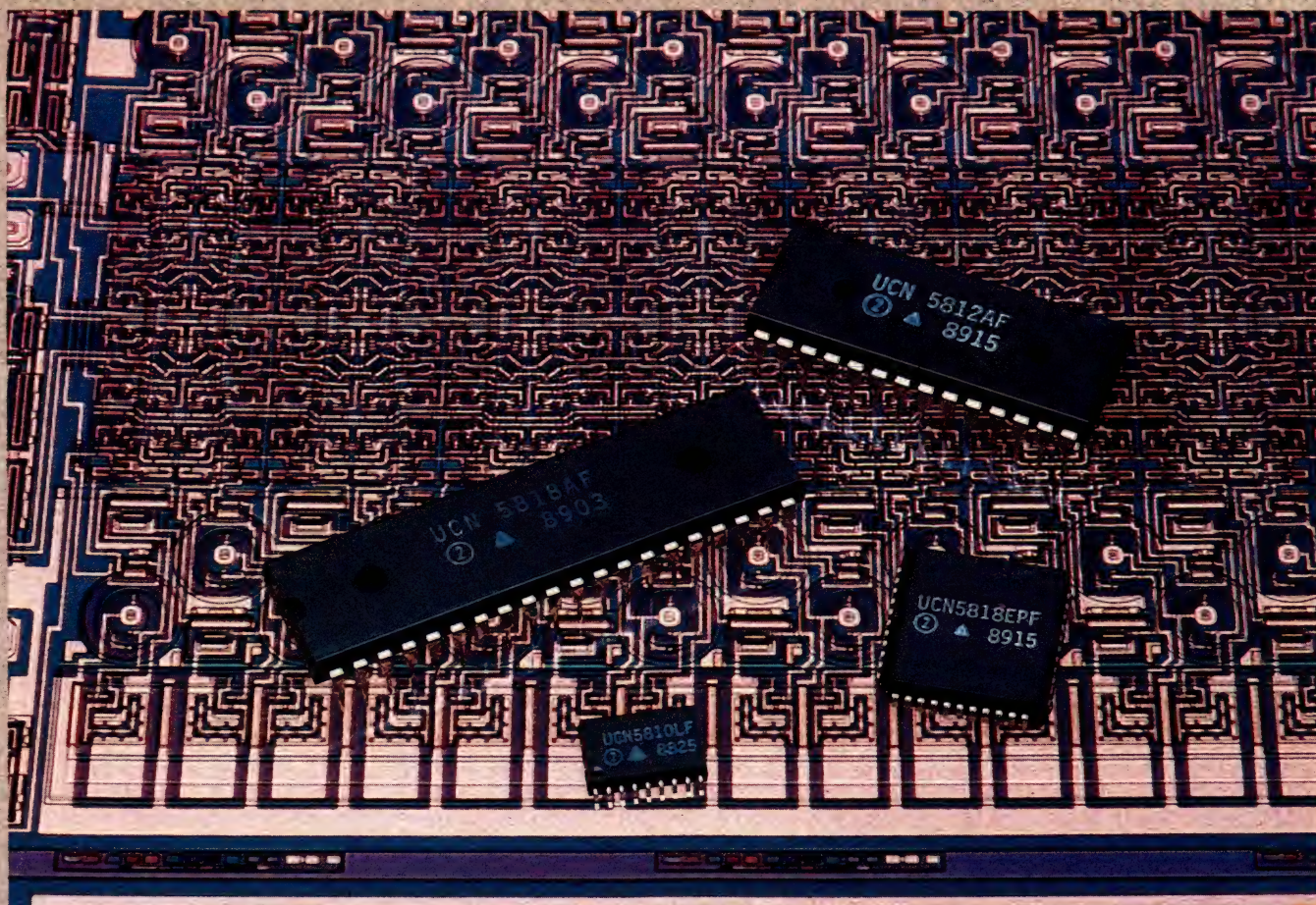
Dave Pryce,  
Associate Editor

Until recently, asymmetric row drive, which requires a positive refresh pulse, was the industry standard. The sole purpose of the refresh pulse is to reverse the charge on the row capacitances so that the pixels will illuminate during the next frame. Because none of the refresh-pulse energy contributes to the display's light output, this energy is wasted. Moreover, because the *on* pixels are charged to a lower potential during the refresh pulse than during the write portion of the cycle, there is a net charge imbalance that can result in a latent-image effect (see **box**, "Display technologies and drive methods"). Although asymmetric drive is still used, designers are rapidly switching to ICs that provide symmetric drive.

## **Symmetry has its own rewards**

With symmetric row drive, light is emitted during both the positive and negative row pulses. Instead of one refresh pulse that drives all rows positive, symmetric drive addresses each row separately. Dur-





ing the negative row pulse, the selected columns add to the magnitude of the row-driver voltage. During the positive row pulse, the selected columns subtract from the row-driver voltage. In other words, symmetric drive writes an entire frame in one polarity, then writes the next frame with the opposite polarity. The result of this symmetric drive is that there is no net charge imbalance—and consequently, no latent-image problem. Unlike asymmetric drive, which requires open-drain drivers, symmetric drive requires either 3-state drivers or complementary pairs of open-drain n- and p-channel drivers. Both drive methods require 225V-rated devices.

The SN75563A and SN75564A from Texas Instruments are representative of the newer breed of symmetric row-driver chips for use with EL displays. Packaged in 44-pin plastic leaded chip carriers, the devices are identical except that the output connections are reversed for ease in pc-board layout. The 34-channel devices (Fig 1) feature

CMOS-compatible inputs and selectable open-source or open-drain outputs rated at 225V and  $\pm 70$  mA. If the Positive Write input is high, the Q outputs act like open-source outputs; output data is not inverted with respect to input data. Conversely, if the Positive Write input is low, the Q outputs act like open-drain outputs, and output data is inverted with respect to input data.

During the typical operation of these row drivers, an external high-voltage switching circuit generates the composite  $V_{CC2}$  and ground signals. Serial data enters the shift register on the high-to-low transition of the clock input. A high Enable input turns on those outputs with a high in their associated register, thus connecting the corresponding row to  $V_{CC2}$  when Positive Write is high, or to ground when Positive Write is low. You can use the Serial Output from the shift register, which is not affected by the Enable or Positive Write inputs, to cascade additional devices. Unit pricing for the SN75563A or

**VF drivers** (Sprague Semiconductor)

*Text continued on pg 106*



## Display technologies and drive methods

The major flat-panel technologies are electroluminescent (EL), plasma (PL), liquid crystal (LC), and vacuum fluorescent (VF). Because of similarities between some display technologies (EL and PL are good examples), you can frequently use the same driver IC for different displays.

Two common classifications exist for flat-panel displays: direct driven and matrix driven. In a direct-driven display, the panel elements are fixed; very little addressing is necessary (for example, in a watch's direct-driven display, addressing is only used to determine which numeric segments are turned *on*). The viewing area of a matrix-driven display is divided into intersecting rows and columns, and its addressing scheme is more complex.

In a typical matrix display, there are several hundred rows, each having several hundred columns. The picture elements (pixels) are the intersections of these rows and columns and are so closely spaced that the eye is not aware of the grain of the structure. The three most popular standards, which define the screen resolution by the number of columns times the number of rows, are

- CGA:  $640 \times 200$  (2 colors) or  $320 \times 200$  (4 colors)
- EGA:  $640 \times 350$  (16 colors)
- VGA:  $640 \times 480$  (16 colors) or  $320 \times 200$  (256 colors).

Most displays have a glass face. In a  $640 \times 480$  display, there are 640 vertically oriented conducting stripes (columns) placed on the inside of the front glass. The next layer of the panel, which is placed between the front glass and the back panel, contains the 480 horizontally oriented conducting stripes (rows). The column stripes on the front glass are made of either tin oxide or indium tin oxide, which

are transparent conductors. Because you don't need to see through the row stripes, they are made of aluminum. The in-between material is the luminous medium: a solid (EL), a liquid (LC), or a gas (PL). A VF display, which works on the same basic principle as a triode vacuum tube, uses phosphor-coated anodes to radiate light.

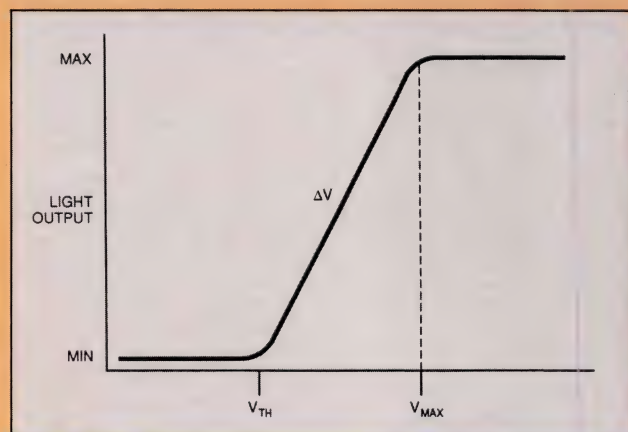
In dc displays, the emitting solid or gas makes contact with the pixel stripes; the driven load is largely resistive. In ac displays, the stripes have an insulating layer deposited on them—there is no actual conduction—and the load is capacitive. In VF displays, the load is capacitive until emission occurs, whereupon the load looks resistive. To a driver, a typical pixel exhibits the characteristics shown in Fig A.

A voltage,  $V_{TH}$ , begins light emission. Above this threshold, light output increases to a maximum ( $V_{MAX}$ ) and then levels off. The typical  $V_{TH}$  for the different technologies varies considerably—from about a volt or so for some LCDs to several hundred volts for EL and PL displays.

The slope between  $V_{TH}$  and  $V_{MAX}$  is important; it must be stable or variations caused by temperature, for example, would cause changes in brightness. If the slope between  $V_{TH}$  and  $V_{MAX}$  is wide enough, there is the potential for generating intermediate levels of brightness, called gray scale. Gray-scale capability is essential for video images such as pictures, and nearly as important for graphics. Conventional alphanumeric data can get by with only two levels of brightness—dark and some level of bright.

The gray-scale potential depicted in Fig A is analog in nature. A pixel driven to  $V_{TH}$  produces no light output. Driving the pixel to as many intermediate levels as possible between  $V_{TH}$  and  $V_{MAX}$  produces a range of gray. When the slope of the curve is nearly vertical, analog-drive gray scale is not possible. However, if the display technology is fast enough, gray-scale generation is possible by subdividing the time a pixel is addressed into shorter bursts ranging from zero to several bursts. The eye integrates the total number of bursts into levels of brightness corresponding to the gray scale. Eight levels of brightness are achievable with some display technologies, and 16-level devices are now appearing on the market.

As mentioned, a display consists of rows of pixels, with each pixel in each row located in columns from left to right. The drivers are usually located on all sides of the panel, (Fig B), because leads from the IC packages are wider than the pixel spacings. Typically, half of the interlaced columns are driven from the left, the other half from the right. Such driver-



**Fig A—The light output of a pixel depends on its driving voltage.** The pixel needs a voltage,  $V_{TH}$ , to begin light emission. Above this threshold, light output increases to  $V_{MAX}$  and then levels off. The  $V_{TH}$  for the different display technologies varies considerably, from about a volt for some types of LCDs to several hundred volts for EL and plasma displays.



placement methods, caused by mechanical constraints, severely complicate the actual drive scheme and its timing.

The drivers themselves are usually serial-to-parallel converters with high-voltage outputs. The available data is displayed a line (row) at a time, and the total number of available lines constitutes a frame. The data enters a chain of column drivers until all of the columns for a row are filled. The data is then latched and the row driver is turned on, driving all the pixels in the row. Meanwhile, new column data is entering the drivers in order to proceed to the next row. Depending on the drive scheme, the exact sequence of row drive can vary; some schemes drive each row in turn, others drive the odd rows first and then the even rows.

An ac EL panel has a characteristic that causes repeated pulses of the same polarity to produce successively dimmer light pulses and rapid degradation of the EL material. Conversely, if the drive pulses alternate in polarity and are of equal amplitude, there is no diminution in light output. This effect has led to different drive schemes for EL displays. In one scheme, called asymmetric drive, all of the rows are sequentially written to the display in the same direction. At the end of the frame, a brief pulse of opposite polarity is emitted by all of the rows to refresh the display. The scanning of the display then proceeds to the next frame.

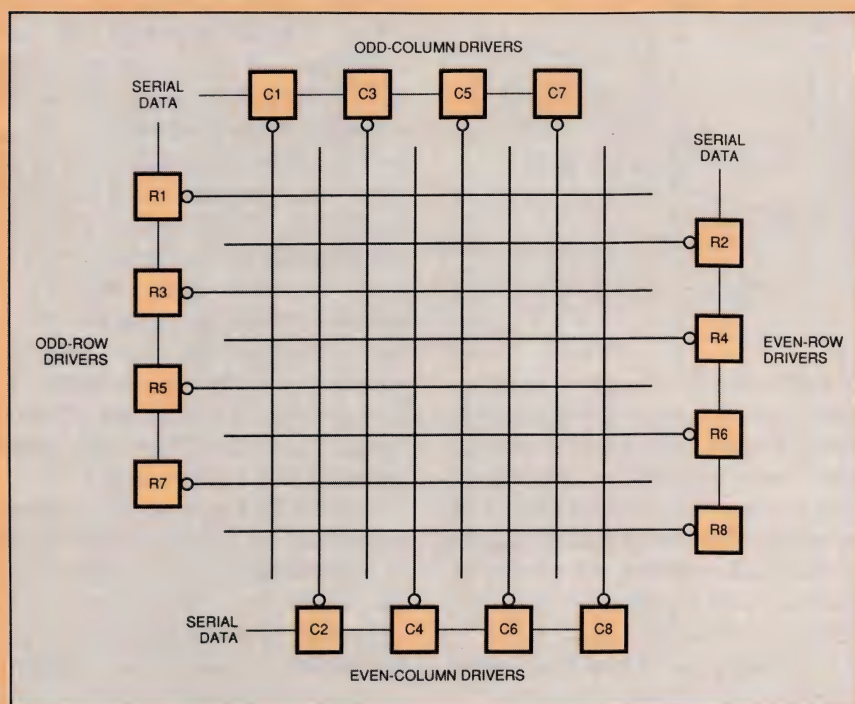
The problem with asymmetric drive is that each row has an indeterminate number of on pixels; a

refresh pulse of average length can't exactly cancel the energy originally delivered to each row. As a result, some pixels may still be on if quasistatic images are displayed for long periods of time. The pattern seen is called a latent image and is similar to a burned-in image on a CRT. Newer drive methods address this problem with ICs that provide symmetric drive. However, not all EL panels are equally susceptible to latent imaging, or equally in need of symmetric drive.

The ac plasma display, which is capacitive in nature, requires an ac-waveform drive. The LCD also requires ac waveforms, which help to prevent long-term degradation to some types of liquid-crystal material. Thus, the need for symmetric drive can easily apply to more than one technology. Moreover, all display types find major use in video terminals and computer systems and must be able to handle video data rates and have fast frame speeds.

## Acknowledgment

*The author wishes to thank Andrew Wolff of Supertex, who provided most of the information contained in the box, "Display technologies and drive methods." Thanks also to Steve Sutton of Texas Instruments, whose conference paper, "Recent developments and trends in thin-film electroluminescent display drivers," proved helpful in the discussion of symmetric row drivers. Thanks also to Dean Channing of Cherry Electrical Products, whose paper, "EL addressing technology" helped clarify the different methods for generating gray scale.*



**Fig B**—In the typical display, half of the interlaced columns are driven from the left, the other half from the right. Drivers that are packaged in complementary left/right pinouts or have pin-selectable left/right drive capability can greatly simplify board layouts.



**The development of symmetric row drivers has practically eliminated the latent-image problem with ac thin-film electroluminescent displays.**

SN75564A is \$11 (1000).

Although basically identical in function to the SN75563A/64A devices, Supertex Inc's HV09 (32 channels) and HV70 (34 channels) differ from the TI devices in that they use complementary n- and p-channel output drivers (Fig 2) rather than two n-channel drivers. The Supertex row drivers feature output-voltage ratings of 250V (HV09) and 230V (HV70). The source and sink current ratings are 200 and 70 mA, respectively. Like the TI devices, the Supertex chips come in 44-pin PLCC packages.

Both of the Supertex symmetric

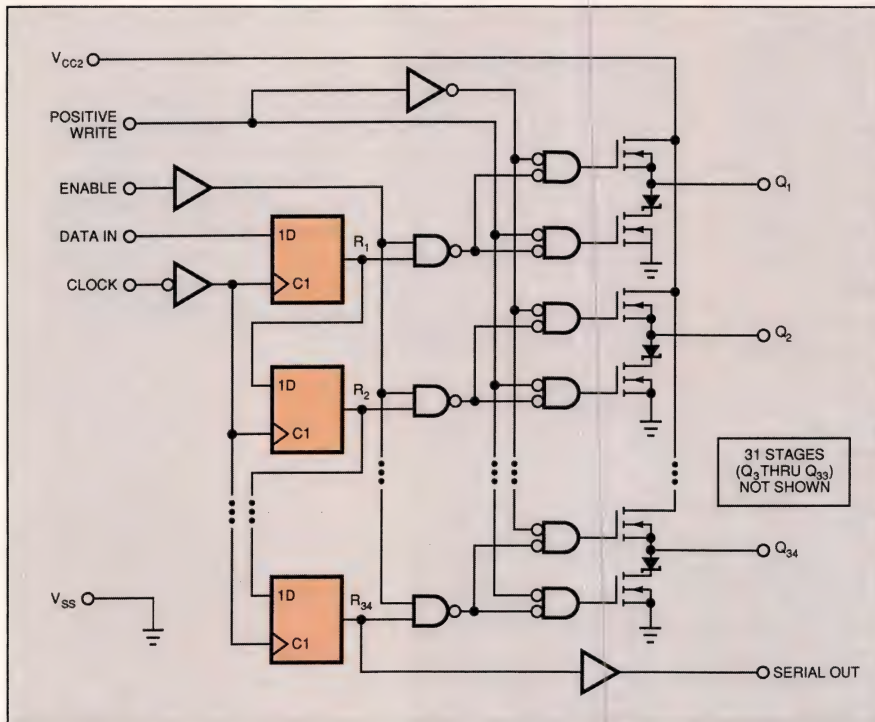
polarity pin is high, or to ground if the polarity pin is low. The shift register in the HV09 and HV70 is capable of speeds to 4 MHz. Although Supertex has not yet established firm pricing, estimated large-quantity unit costs are \$0.20/channel for the HV09 and \$0.10/channel for the HV70.

**Gray-scale chips improve display**

Another problem that designers of flat-panel displays and IC manufacturers have been struggling with is the generation of a gray scale for monochrome displays. Although shades of gray are not important for black-and-white text, they are of paramount concern when you need to reproduce pictures or color graphics on a monochrome display. There are two different methods currently used for generating a gray scale—the analog ramp and pulse-width modulation. Both methods modulate the column drivers in a flat-panel display.

One example of an IC that uses the analog-ramp method is the Supertex HV08 24-channel column driver. Fig 3 illustrates the basic operation. If the current source (CS) is turned on for a full period, capacitor C will charge to  $V_{RAMP}$  ( $\approx V_{PP}$ ). A full period is equal to the time the counter takes to count down from  $2^4$  (16) to  $2^0$  (1). If a microprocessor loads the shift register with all ones, there will be 16 counts, charging capacitor C to  $V_{RAMP}$  and driving the follower's output to nearly  $V_{PP}$ . A count of 8 would produce an output of about  $\frac{1}{2}V_{PP}$ . Thus, the HV08 can produce as many as 16 gray shades.

The HV08 can generate a modulation voltage as high as 70V; it has a high-voltage output source and sink capability of 40 mA min and a data-shift rate of 6 MHz; it can perform the D/A conversion in as little as 3  $\mu$ sec. The device, which comes in a 44-pin PLCC, also provides a



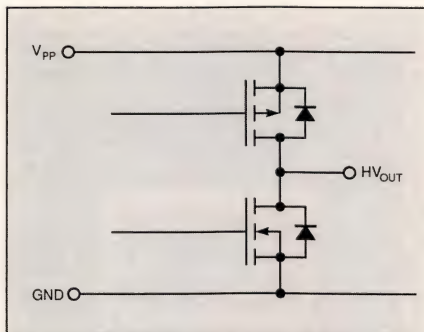
**Fig 1—This symmetric row-driver chip set, the SN75563A/SN75564A from Texas Instruments, can help eliminate latent-images from electroluminescent displays. The device has 34 output channels rated at 225V and  $\pm 70$  mA.**

row drivers offer the same features, and they operate as low-voltage serial to high-voltage parallel converters. These features include a direction pin for either clockwise (CW) or counter-clockwise (CCW) loading of the shift register, an output-enable pin, and a polarity-control pin. The chips load the data input on the falling edge of the clock pulse; a logic high causes the output to swing to the supply voltage if the



shift-direction pin that lets you interchange the function of the shift-register data-input and -output pins. When the direction-pin input is high, data is shifted in a CW direction; when the input is low, data is shifted in a CCW direction. Supertex estimates large-quantity unit costs for the HV08 at \$.20/channel.

Cherry Electrical Products (Waukegan, IL), uses the other method for generating gray shades—pulse-width modulation—in its EL panels. These displays use the Supertex HV77 64-channel serial-to-parallel converter as a column driver and a custom chip to generate the gray scale. Cherry apparently chose this approach for two reasons. First, at about \$.10/channel, the combination is very cost-effective (the HV77 alone costs about \$.05/channel in OEM quantities). Second, with pulse-width modulation, the operating point of the EL panel is always the same, a characteristic that Cherry feels is particularly important for its dc panels. The output of the gray-scale chip is the data input for the column driver and determines the width of the high-voltage pulse to the dis-



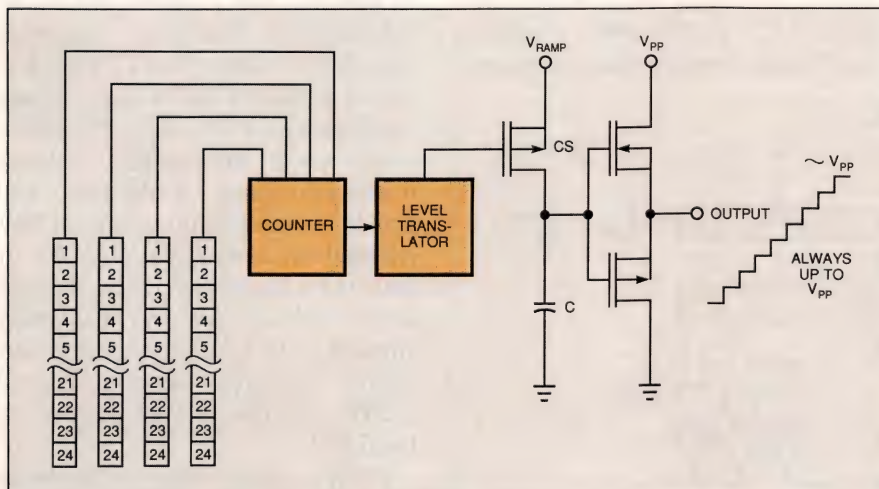
**Fig 2—This output-stage configuration uses complementary n- and p-channel transistors.** Such a configuration is typical of the HV09 and HV70 symmetric row-driver chips from Supertex.

play. Fig 4 shows the timing of the pulse-width-modulated signal, which can provide as many as 16 levels of brightness. The value of a 4-bit nibble from the gray-scale chip determines the number of periods the pulse remains on.

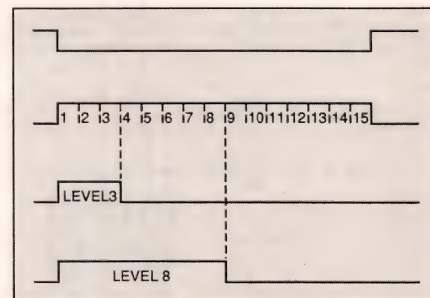
Vacuum-fluorescent and liquid-crystal displays also benefit from higher-performance chips. For example, the Sprague Electric Semiconductor Group's UCN5810 (10-bit), UCN5812 (20-bit), and UCN5818 (32-bit) drivers are used with vacuum-fluorescent displays. Fabricated in Sprague's BiMOS II process, these "smart-power" drivers (Fig 5) combine a low-power,

high-speed shift register, data latches, and control circuitry with 10, 20, or 32 high-speed bipolar outputs that have active DMOS pull-down circuitry. The shift register and data latches allow direct interfacing with  $\mu$ P-based systems, and a CMOS serial-data output pin allows cascading of additional devices.

Along with the ability to sink 3.5 mA, the DMOS active pull-downs in these devices exhibit a maximum impedance of only 3 k $\Omega$  vs the 5-k $\Omega$  max impedance of competitive devices, a feature that provides faster, more positive blanking of the display digits and allows high refresh rates. This feature can eliminate interdigit "ghosting," in which a turned-off display character has insufficient time to extinguish completely before a new character fully turns on. Typically, these drivers can operate at 5 MHz with a 5V logic supply and at 7.5 MHz with a 12V supply. The drivers have output ratings of 60V at -40 mA and feature low logic-supply currents. The UCN5818, for example, has a maximum logic-supply current of 200  $\mu$ A in both the on and off states—about one-tenth that of competitive devices, according to Sprague. The drivers come in a variety of package styles including DIP, PLCC, and SOIC. Prices start at \$1.60 (5810), \$2.68 (5812), and \$4.73 (5818) (100).



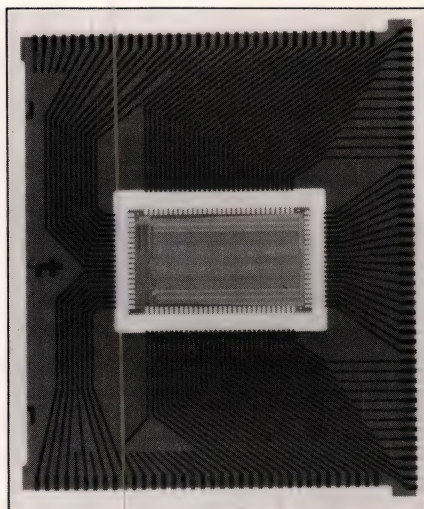
**Fig 3—In this gray-scale column driver, the output is digitally ramped to a given level.** The current source in this Supertex HV08 device charges the capacitor for a time set by the number of pulses in the counter, which is determined by the number of bits in the shift registers. With 4 bits in each shift-register, 16 output-voltage levels (gray shades) are available.



**Fig 4—Another method for generating a gray scale uses pulse-width modulation.** Depicted here are two different levels of gray (out of a total of 16), which are determined by the pulse width.



Two methods generate a gray scale for monochrome displays—the analog ramp and pulse-width modulation.



The PCF2201 row/column LCD driver in a tape-automated-bonding (TAB) package (Philips Components)

Another device that is extending the performance boundaries for flat-panel displays—in this case LCDs—also extends the packaging boundaries. The PCF2201 LCD driver from Philips is encapsulated in a 120-pin tape-automated bonding (TAB) package that keeps all of the wiring on a single plane, thereby eliminating the need for costly, double-sided substrates. Implemented in a CMOS p-well, polysilicon-gate process, the device cuts the typical power needed to drive a  $640 \times 400$ -pixel LCD to 100 mW. According to Philips, this low power consump-

tion enables battery-operated equipment such as portable computers to work nearly twice as long without recharging than was heretofore possible.

The PCF2201 features a data-transfer rate of 16M bps and multiplex rates from 1:32 to 1:256; it drives both conventional twisted-nematic displays and the most recent SBE (super-twisted, birefringent-effect) LCDs. Controlled by any industry-standard LCD controller, you need only 21 PCF2201s to drive a  $640 \times 400$ -pixel SBE display. The IC converts display data into parallel LCD drive waveforms for as many as 81 rows or 80 columns. It also includes an electronically implemented left or right orientation, a feature that simplifies system design and reduces inventory requirements.

The IC accepts 4-bit parallel or serial data from an external alphanumeric graphics-controller chip. When used as a row driver, the PCF2201 serially clocks the scanned data through the 81 bidirectional shift-register cells to provide a selectable scan configuration. When used as a column driver, the shift registers hold column data until the next line is assembled in the data latches. The data conversion uses level shifters from 5V logic levels to generate the 4-level signals to drive the LCD. The PCF2201, which costs \$6 (50,000), includes overtemperature protection and provides a maximum output of 25V (needed by supertwist LCDs). It features a typical operating current of 0.4 mA at 25V and a standby current of 15  $\mu$ A, and it needs four supply voltages between 5 and -20V for the 4-level signals to the LCD.

Philips, along with its Signetics subsidiary, also offers several other driver chips for LCDs, including the PCF8578 row/column driver and the PCF8579 column driver. Com-

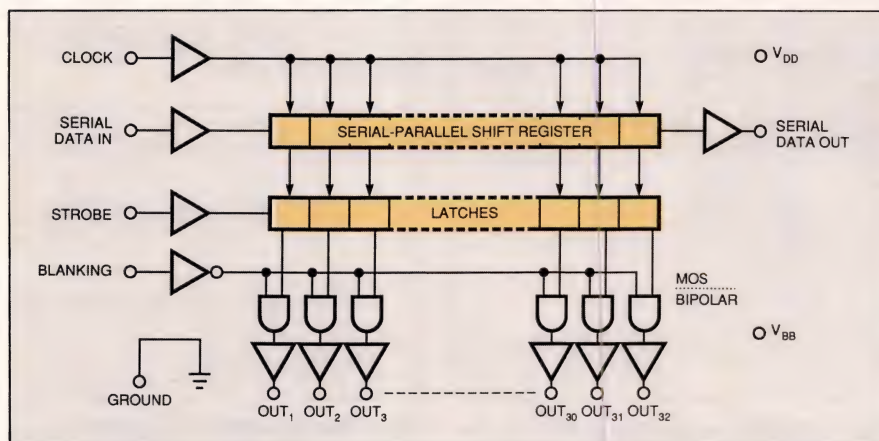


Fig 5—Designed primarily for use with vacuum-fluorescent displays, the UCN5818 from Sprague Semiconductor provides 32 outputs and features latched source drivers with active DMOS pull-downs.



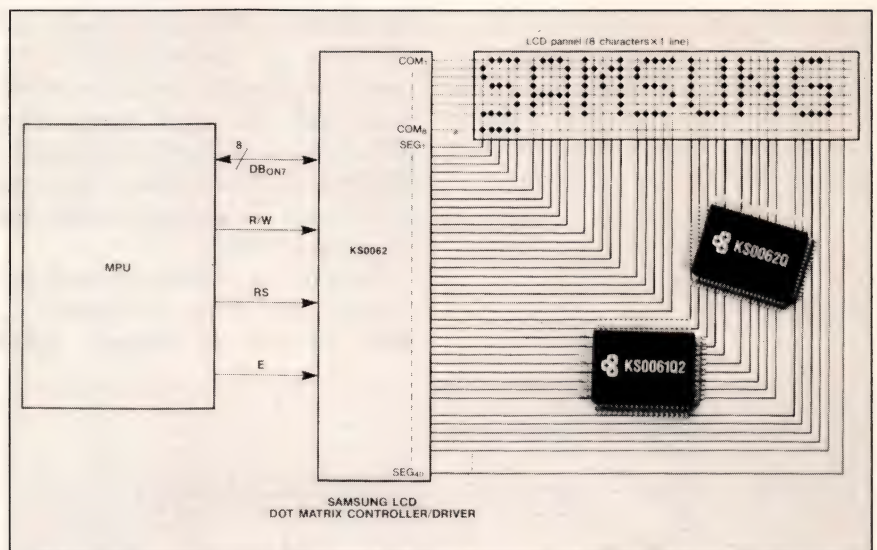
patible with the I<sup>2</sup>C bus (a 2-line bidirectional bus), these chips are suitable for medium-multiplex-rate, dot-matrix LCDs. The chip set typically consumes only 20  $\mu$ A of current per chip—about one-twentieth that of competing chips, claims Philips. The chips can drive graphics or character displays at multiplex rates between 1:8 and 1:32, and you can configure the chips to drive as few as 256 or as many as 40,960 dots. The chip set, which operates from supplies between 2.5 and 6V, is suitable for a variety of battery-powered equipment (in telecommunications and automotive applications, for example).

The PCF8578 row-and-column controller/driver has 40 outputs, which are suitable for driving a 5  $\times$  8 dot-matrix character display. Standing alone, and depending on the multiplex rate, the device can drive as many as 384 dots in various combinations of rows and columns. The selectable multiplex rates enable the IC to drive between 8 rows of 32 pixels and 32 rows of 8 pixels. You can cascade the 8578 with one or more 8579 40-output column drivers for larger horizontal displays. The 8578 provides the clock signal and the display synchronization for the 8579. The 8578 works with as many as 32 cascaded 8579s, either as a row/column driver or as a row driver with as many as 32 output rows. The PCF8578 and PCF8579 come in a variety of packages, including a 56-pin minipack and a 64-lead tape-automated-bonding module. The devices cost from \$2 to \$5, depending on quantity.

### High-voltage LCD drivers

Although the majority of flat-panel displays suit applications in the commercial and industrial markets, the military also uses a variety of display types, including LCDs. Military applications generally use dichroic LCDs, which pro-

vide superior contrast, wider viewing angles, higher speed at low temperatures, and less light bleed-through in darkness. However, dichroic LCDs require higher voltages to achieve these benefits. Moreover, to ensure device reliability in critical systems such as avionics displays, the military prefers to derate ICs by 50%. This supply-voltage derating provides an addi-



tional safety margin for protection against power-supply line transients. When given a choice, the military prefers to use a 100V device in a 50V application.

Until recently, the available driver ICs topped out at about 32V, generally the maximum available from standard CMOS devices—and the voltage at which the advantages of dichroic LCDs begin. The MIC8031 from Micrel Semiconductor, however, has changed the ground rules. Fabricated with a low-voltage CMOS and high-voltage DMOS technology, the IC features a 100V rating and can drive dichroic displays at 35 to 60V and still maintain an extra margin of reliability.

The MIC8031 (Fig 6) operates as follows: The TTL/CMOS-compatible serial input sends data into a

**Dot-matrix controller/driver** (Samsung Semiconductor)



**Low-power LCD row/column drivers help reduce power drain for battery-operated equipment such as portable computers.**

38-bit shift register, which, on command, loads a 38-bit latch register. The latch register controls the high-voltage output drivers, which can drive 30, 32, or 38 segments. An RC-controlled internal oscillator provides the backplane frequency or, in the case of multiple cascaded devices, the master chip's backplane frequency. The oscillator input automatically detects whether the chip is self-oscillating or being driven in the slave mode, and switches a divide-by-256, frequency-stabilizing circuit in or out. Load and chip-select inputs allow  $\mu$ P control of system operation. The MIC8031 operates from a logic supply of 5 to 15V; its high-voltage supply is 20 to 100V.

Each of the device's 38 push-pull outputs can drive a maximum of 4000 pF of capacitance, which

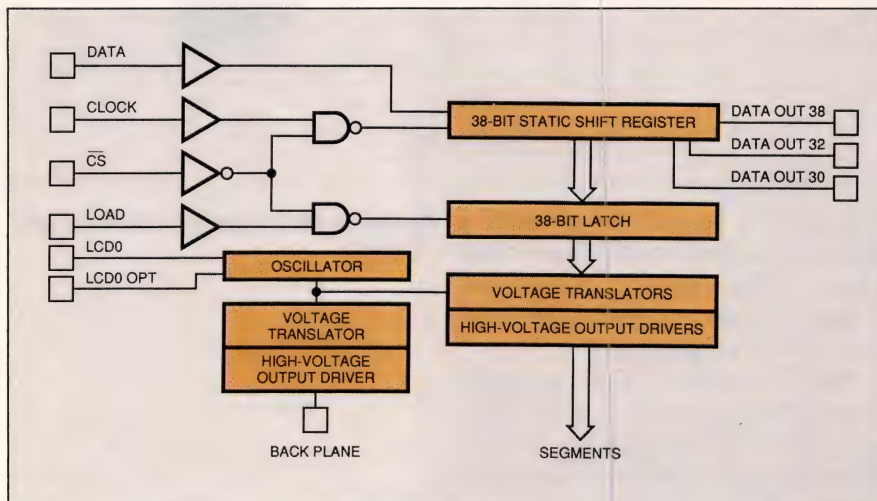
(alphanumeric) displays and two for use with graphics displays. The two character-display types are the KS0061, a 40-channel segment/common driver, and the KS0062 controller/driver.

The segment driver has two sets of 20-bit bidirectional shift registers, 20-bit data-latch circuits, and 20-bit driver circuits. A direct replacement for the comparable Hitachi driver, the KS0061 receives serial display data from the controller section of the KS0062, converts it into parallel data and supplies waveforms to the dot-matrix LCD panel. The data can drive a static or dynamic liquid crystal and is usable as a common driver or a segment driver.

The more complex KS0062 controller/driver contains an on-chip character ROM and can provide multiplexed ac drive to the LCD. The chip also contains a display data RAM for 80 characters (80  $\times$  8 bits). In addition to its drive capability, the KS0062 offloads a number of display housekeeping chores from the main processor. The KS0062 is a direct replacement for the comparable Hitachi device and interfaces with 4- or 8-bit  $\mu$ Ps to drive a dot-matrix LCD that produces alphanumeric, characters, or symbols. The chip set can display as many as 80 characters simultaneously. The KS0061 (60-pin flat pack) costs \$5.61; the KS0062 (80-pin flat pack) costs \$11.25 (100).

The drivers for graphics displays are the KS0101 68-channel common driver and the KS0102 80-channel segment driver. The KS0101 contains 68-bit bidirectional shift registers, 68-bit level shifters and 68-bit 4-level drivers. Although the chip has a 68-channel output, you can drive a wider dot-matrix panel by paralleling devices.

The KS0102 contains 80-bit bidirectional shift registers, 80-bit data latches, 80-bit level shifters, and 80-



**Fig 6—**With 38 high-voltage outputs, the MIC8031 from Micrel Semiconductor can drive both dichroic and standard liquid-crystal displays. Because of its 100V rating, the device is particularly useful for driving dichroic LCDs in military applications.

makes the device suitable for use with other displays such as plasma, vacuum fluorescent, and ac electroluminescent. The MIC8031 comes in a 48-pin plastic DIP and a 44-pin ceramic LCC package for MIL-STD-883C operation. Pricing for commercial versions start at \$27.90; military versions cost \$54.50 (100).

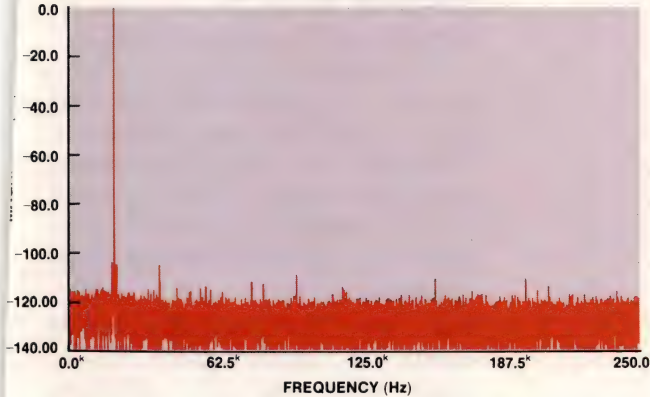
A quartet of LCD drivers from Samsung Semiconductor includes two devices for use with character



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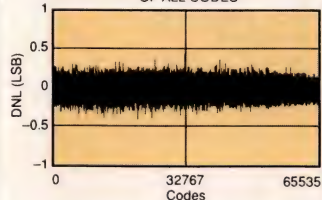
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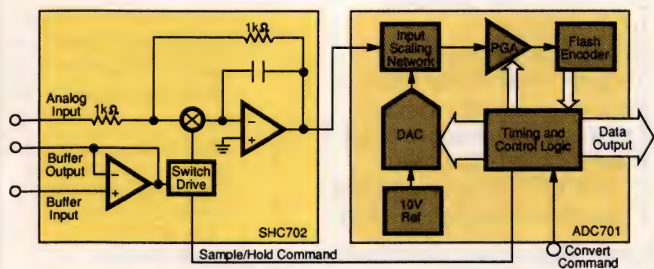
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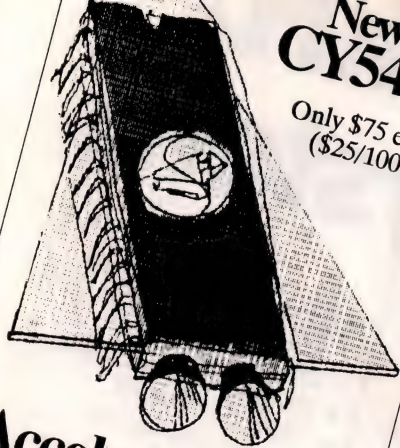
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The use of high-voltage (100V) drivers can improve the reliability of military equipment that uses dichroic LCDs operating at 35 to 45V.

bit 4-level drivers. The device receives 4-bit parallel display data from the controller and then puts the driving waveform into a dot-matrix LCD panel. A power-down function keeps the power consumption of this CMOS device at a minimum. The KS0101 (80-pin package) costs \$14.50; the KS0102 (100-pin flat pack) costs \$15.75 (100). Clearly, the symmetric row drivers and gray-scale chips described here are adding new performance dimensions to electroluminescent (and other) displays. Manufacturers are also providing the designer with chips that function with ever-lower operating currents—always a driving force for battery-operated equipment. Completing the picture, chips with selectable left-right drive are providing greater versatility and ease in board layouts, as are innovations such as tape-automated-bonding (TAB) packages.

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For more information on the display drivers discussed in this article, circle the appropriate numbers on the Information Retrieval Service card or use EDN's Express Request service. When you contact any of the following manufacturers directly, please let them know you saw their products in EDN.

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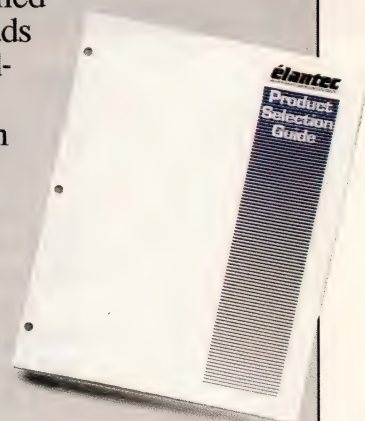
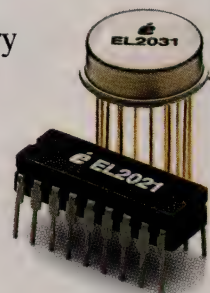
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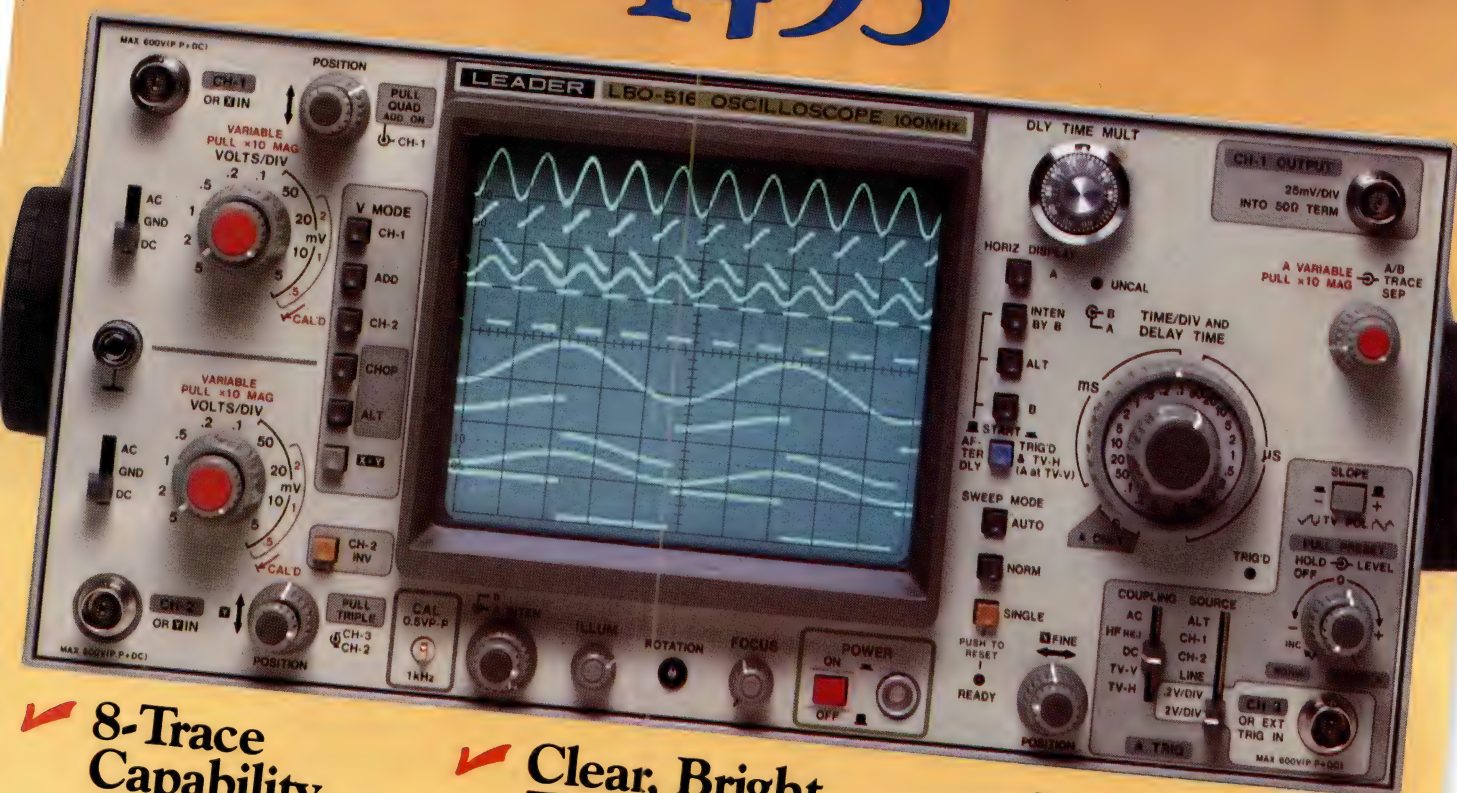


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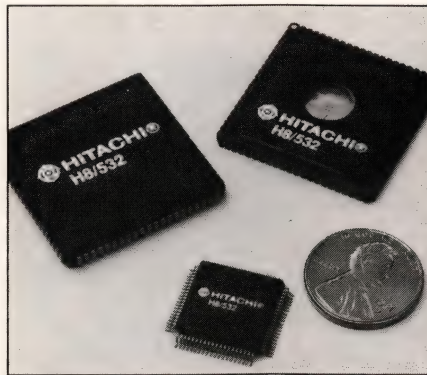


# Integrated Circuits

## 8-bit microcontroller incorporates a slew of peripheral functions

The H8/532 is an 8-bit  $\mu$ C that features more than 25 built-in analog and digital peripheral functions. Its internal structure and memory capacity enable the device to support high-level languages. The device offers a dual ALU structure with a 16-bit-wide internal data path that lets the CPU run at 10 MHz. Instructions execute in 200 to 400 nsec.

The H8/532 provides plenty of memory space: 32k bytes of EPROM and 1k byte of RAM. The chip lets you access external memory either with or in place of the internal memory. Its five operating modes consist of internal memory only, internal and 64k-byte or 1M-byte external memory, or either of



the external memory capacities alone.

Other features include a 10-bit A/D converter, an 8-input multiplexer, and four 16-bit registers that buffer the data. The converter has its own S/H circuit and offers a 13.8- $\mu$ sec conversion time.

Digital data paths on the H8/532 include nine I/O ports and a serial-communications interface with a baud-rate generator. The serial interface handles either synchronous or asynchronous communications at a data rate of 2.5M bps max. The I/O ports include 57 bidirectional lines and eight input-only lines.

The H8/532 is available in windowed-EPROM and one-time-programmable versions in either an 84-pin plastic leaded chip carrier or an 80-pin quad flat pack. It costs \$59 (100).

**Hitachi America Ltd, 2210 O'Toole Ave, San Jose, CA 95131. Phone (408) 435-8300.**

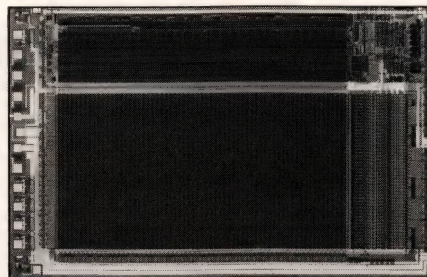
Circle No 445

## Content-addressable memory yields address when given data

The Am99C10 memory device works in reverse: You give it data, and it gives you the address. Content-addressable memory (CAM) is suited to applications that require frequent searches for specific information.

The Am99C10 CAM is organized as 256 16- or 48-bit words and includes a mask register. When you present data to the CAM, it performs 256 simultaneous comparisons between the memory and the data word. You can use the register to selectively mask any or all bits from the comparison process. If the CAM finds a match, it sets a flag and identifies the address of the matching word.

To identify all the matches, you must use two additional bits of



memory located at each cell—the empty bit and the skip bit. Both bits can disable a match for their word. The empty bit indicates that a memory cell is available for new data; the skip bit lets you identify all matching words other than the word with the lowest address. To locate the multiple matches, set either the skip bit or the empty bit for each matching word and repeat this match operation until the CAM

stops issuing a match signal.

The CAM lets you write the skip and empty bits of each word individually. You can either clear or set all the empty or skip bits simultaneously. Further, the device automatically clears the two bits when you write new data to a memory cell.

The Am99C10 CAM is a TTL-compatible CMOS device. It operates at 5V with 100-nsec cycle times and draws a maximum of 715 mW. Priced at \$42.50 (100), the device comes in a 28-pin ceramic or plastic DIP or in a 32-pin plastic leaded chip carrier.

**Advanced Micro Devices Inc, 901 Thompson Pl, Sunnyvale, CA 94088. Phone (408) 732-2400.**

Circle No 446



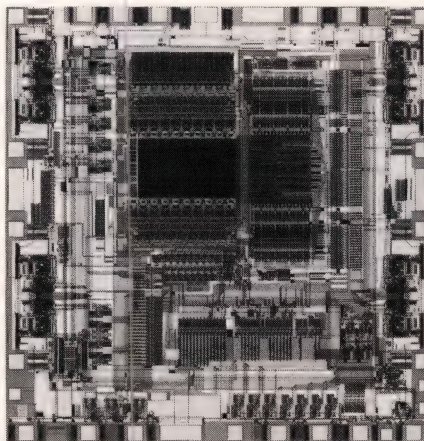
# Integrated Circuits

## ECL-compatible PLDs offer propagation delays of 6, 4, 3, or 2.5 nsec

If you'd like to combine the convenience of programmable logic with speed for your ECL design, consider the BiCMOS CY10E301 and CY10E302.

These devices are available in three speed ranges and two power levels. Standard-power 301 devices consume 240 mA; 302s consume 220 mA. Low-power versions of both devices consume only 150 mA. Propagation delay times are 6, 4, or 3 nsec for the 301 and 6, 4, or 2.5 nsec for the 302. The low-power versions are only available with 6-nsec speeds. Both the CY10E301 and CY10E302 are compatible with 10KH series ECL.

The CY10E301 features 12 input, four input/output, and four output-only signal lines. Each output signal comes from an AND-OR logic combination of the input and output sig-



nals or their complements. Each output line also offers selectable polarity, thus allowing you to specify either high or low as the active logic state. The device is functionally equivalent to an industry-standard 16P8.

The CY10E302 offers eight input

and four output signal lines. Output signals are logic combinations of input signals and their complements only; output signals are not available to the AND-OR array. This device is equivalent to the 16P4.

Both devices offer a security feature—a fuse that, when blown, prevents the design pattern from being read. You can choose 24-pin ceramic DIPs or 28-pin LCCs for standard-power devices. The low-power versions come in plastic or ceramic DIPs or plastic leaded chip carriers. The 3-nsec CY10E301 costs \$55.45; the 2.5-nsec CY10E302 is \$66.50 (100). Low-power versions in plastic DIPs cost \$37 and \$44.35 (100), respectively.

**Cypress Semiconductor, 3901 N First St, San Jose, CA 95134. Phone (408) 943-2600.**

Circle No 447

## $\mu$ P packs workstation power and graphics ability in 1M-transistor chip

The 80860 microprocessor, with more than 1,000,000 transistors, integrates a RISC core, a floating-point unit (FPU), a graphics memory-management unit (MMU), an instruction and data cache, and a bus control unit. At 40 MHz, the chip achieves 80M flops and can sustain 500,000  $4 \times 4$  matrix transformations/sec. In addition, the graphics MMU can Gouraud-shade 50,000 100-pixel triangles/sec.

The RISC core has a  $32 \times 32$ -bit integer register file. This core decodes and executes load, store, integer, bit, and control-transfer instructions. It also fetches floating-point as well as integer instructions

and can operate in parallel with the FPU.

The FPU has a separate register file that you can configure as  $8 \times 128$ ,  $16 \times 64$ , or  $32 \times 32$  bits. Both the adder and multiplier units can provide one result for every clock cycle. When pipelined, they operate at 2 results/clock cycle, thus yielding the 80M-flops rate.

The MMU can translate addresses from linear logical space to linear physical space for both instructions and data. The processor stores translated address information in a table and caches the table in a 64-entry, 4-way associative memory. The page tables are com-

patible with those of the 80386. The data and instruction caches' aggregate bandwidth is 1G byte/sec. Both caches are 2-way set-associative memories divided into 32-bit blocks. The instruction cache is 4k bytes; the data cache is 8k bytes.

The bus-control unit works with conventional static-column dynamic RAM. A pin indicates whether the next address takes place using the same page. The unit supports both pipelined and nonpipelined operation and costs \$750.

**Intel Corp, 3065 Bowers Ave, Santa Clara, CA 95051. Phone (408) 987-8080.**

Circle No 448



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# Integrated Circuits

## Ethernet controller chip supports 32-bit transfers

Although a latecomer to the LAN-controller market, the 92C28 Ethernet controller chip promises to deliver unusually high system performance through its 32-bit interfacing capability. The \$35 (5000) device can operate as a local bus master or as a slave to a host  $\mu$ P, and it maintains a full complement of network statistics as defined by the IEEE-802.3 layer-management draft specification. Because the device uses design rules compatible with NCR's 1.5- $\mu$ m ASIC fabrication process, the vendor can develop alternate versions of the controller for specific applications.

Internally, the 92C28 employs a 16-bit architecture. You can con-

nect the IC to a host  $\mu$ P as a slave device by using either a memory-mapped or an I/O-mapped interface—the chip has control pins for both interface types. The chip can also share its buffer memory with a  $\mu$ P through a DMA request/acknowledge protocol.

Through multiplexing, you can adapt the 92C28's 16-bit data bus to a 32-bit system. Using a 32-bit interface improves the match between the LAN controller and a 32-bit  $\mu$ P. The interface also boosts system performance by raising the maximum data-transfer rate to 20M bytes/sec.

The Ethernet controller's 32-bit mode supports 256k bytes of buffer

RAM compared with only 128k bytes for the 16-bit mode. The device maintains several network performance statistics in on-chip registers. In addition, the chip records error statistics relating to the transmitting and receiving of packets.

The 92C28's network-maintenance statistics registers implement the functions listed in the IEEE-802.3 layer-management draft specification, thus encouraging you to integrate layer-management functions in your Ethernet designs.

**NCR Corp, Microelectronics Div, 2001 Danfield Ct, Fort Collins, CO 80525. Phone (800) 334-5454. FAX 303-226-9556.**

Circle No 449

## Quad-port RAM solves contention and arbitration problems

The DS2015 quad-port serial RAM uses 4-way-access memory cells to permit simultaneous message passing among four independent devices at transmission rates of 4M bps.

This CMOS IC routes data from a given channel to any of the chip's four storage centers, storing the data until the intended recipient is ready for it. It then distributes the data and produces a signal when the message transfer is complete. This design provides simultaneous reading of data from any of four independent control points.

With this capability, you avoid having to resort to complex software algorithms and handshaking protocols in order to arbitrate access to memory. Accordingly, you



remove an extra processing burden from your  $\mu$ Ps by eliminating such overhead logic, which in turn increases the speed with which the  $\mu$ Ps can transfer data. You also avoid the data corruption that can occur during bus contention.

The DS2015 comprises four banks of 8-byte registers. Each port can read and write to its own bank and read the three other ports' banks.

One additional byte in each bank serves as a flag register. This chip routes data from a given channel into one of the four storage areas and signals the presence of data in that area. Communication with each of the four ports occurs via a 3-wire serial bus, which is standard in most  $\mu$ Ps. Its CMOS fabrication lets you build the DS2015 into a battery-powered, free-standing 4-port connector.

Available as either an 18-pin DIP or a small-outline package, the DS2015 sells for \$6.25 (100).

**Dallas Semiconductor, 4350 Beltwood Pkwy S, Dallas, TX 75244. Phone (214) 450-0400. FAX 214-450-0470. TWX 650-244-1669.**

Circle No 450



# Powersupplies for cellular radios and other electronic devices



All cellular radios can be used in connection with 110 or 220 V AC. All you need is a small powerful unit that converts AC to 12 V DC. This will extend the use of your cellular radio enormously. Just plug in the Mascot unit wherever you have access to a power line and the connection is yours. In fact, most electronic devices are low voltage, DC operated and require suitable AC/DC converters. Mascot Elec-

tronic is Scandinavias' largest manufacturer of power supply units with a complete range of more than 50 models - AC/DC power supplies, DC/DC converters, DC/AC inverters, battery eliminators, chargers..... And even more, customer specified units in small or large series on request. Since 1964 we have delivered more than 4 million power supply units to the leading electronics industry in Europe. So whenever you need reliable power supplies, ask for Mascot.

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# Integrated Circuits

## Complete 10- $\mu$ sec CMOS 12-bit ADCs include fast track-and-hold amplifier

It is much easier to use an A/D converter (ADC) when all the required circuit functions are included in a single package. The MAX163, MAX164, and MAX167 are complete 10- $\mu$ sec CMOS 12-bit ADCs. The chips include a successive-approximation 12-bit converter, a track-and-hold (T/H) amplifier, a buried zener voltage reference, a 16- or 8-bit  $\mu$ P interface, and a crystal or an external clock-driven oscillator—everything except external decoupling capacitors.

Often, internal T/H amplifiers are slew-rate limited, thus limiting the input signal to a frequency that can be much less than the sample rate. In the sample mode, the full-power

bandwidth of the T/H amplifier within the MAX163, -164, and -167 ADCs is typically 6 MHz. Such a wide bandwidth lets you use these devices for undersampling applications that let you convert a band-limited signal at a higher frequency than the sample rate.

Because the input bandwidth of these ADCs is more than 10 times the sample rate, you can be sure that the input section will not cause any frequency roll-off of the signal you're converting.

The MAX163, -164, and -167 ADCs have an aperture jitter of less than 100 psec. This parameter allows accurate conversion of 12 bits at a rate as high as 777 kHz—

more than seven times the 100-kHz-max sample rate.

The three different versions of the ADC differ only in their input ranges. The MAX163 accepts 0 to 5V inputs; the MAX164 and MAX167 accept -5 to +5V and -2.5 to +2.5V inputs, respectively. The ADCs are powered by 5 and -12 or -15V; consume a maximum of 180 mW; come in a 24-pin, 300-mil DIP; and cost \$21.25 (100).

**Maxim Integrated Products, 120 San Gabriel Dr, Sunnyvale, CA 94086. Phone (408) 737-7600.**

Circle No 451

## 80486 32-bit CPU breaks new ground in chip density and operating performance

Fabricated in the company's 1-micron CHMOS-IV process, the 32-bit 80486 contains 1,180,235 transistors on a 649  $\times$  414-mil chip. By contrast, Intel's popular 32-bit 80386 chip contains about 275,000 transistors. In addition to an enhanced 386-type CPU, the 80486 contains an enhanced 387-type floating-point unit, an 8k-byte cache, and memory management with paging.

Both the data bus and the address bus of the 80486 are 32 bits wide. In the burst mode, the 80486 can transfer data at a rate of 106M bytes/sec at 33 MHz. The chip has a physical-memory address range of 4G bytes and a virtual-memory address range of 64 terabytes.

The 486 is 100% binary compatible with the 386, but it uses RISC design techniques to achieve a two-fold to fourfold improvement in performance over the 386 processor. At 25 MHz, the 486 operates at 15 to 20 VAX MIPS and executes 37,000 Dhrystones/sec. Moreover, the on-chip 387 coprocessor provides the 486 CPU with a capability of 6.1M double-precision Whetstones/sec.

The on-chip 387 coprocessor meets the increasing demand for floating-point performance in numeric-intensive applications. Also adding to the performance of the 80486 is the built-in, set-associative cache, which optimizes hit rates and processes frequently used instruc-

tions in a single clock cycle. Other features include multiprocessor instructions, multilevel cache support, bus-snooping logic, and hardware bus arbitration.

Samples of the 25-MHz version of the 80486 will be available in the third quarter of 1989. Production quantities will be available in the fourth quarter along with samples of a 33-MHz version. The 80486 comes in a 168-pin pin-grid-array package, and the 25-MHz version costs \$950 (1000).

**Intel Corp, 3065 Bowers Ave, Santa Clara, CA 95051. Phone (408) 987-8080. TWX 910-338-0026. TLX 346372.**

Circle No 452



# Breaking the TTL Speed Barrier

## Propagation Delay

### Function

Buffers

Transceivers

Registers

Latches

FCT-A

6.5ns

7.0ns

8.0ns

10.0ns

Over commercial temperature supply range

FCT-A

4.8ns

4.6ns

6.5ns

5.2ns

FCT-C

3.7ns

3.7ns

4.2ns

4.2ns

## 3.7 ns FCT-C Logic from IDT

### World's first logic < 4 ns

We set the standard three years ago with our FCT-A logic family. Today we are announcing a speed breakthrough and setting a new standard with our FCT-C logic family which is up to 30% faster than FCT-A logic. By using FCT-C logic, 33 MHz high-performance microprocessor systems can realize a 10% increase in timing margin safety factors.

### The need for speed

You need the fastest TTL logic to optimize system performance and lower system cost. Our FCT-C buffers and transceivers operate at 3.7 ns, eliminating speed bottlenecks to achieve significantly higher system performance. FCT-C is the best TTL solution for 25 MHz and 33 MHz RISC- and CISC-based systems.

### Good, better, best — IDT has the fastest logic

Our CMOS products have established IDT as the industry's speed leader, and today we have the fastest TTL logic you can buy. Our FCT family matched FAST™ specifications; the FCT-A family was 40% faster. Now our FCT-C family is *over 55% faster* than the best bipolar devices!

FCT-C devices offer 64 mA output drive for heavy capacitive loading and better signal quality. And all the benefits of low CMOS power levels, at less than one-third the dynamic power consumption of equivalent bipolar logic.

FCT-C devices are pin and function compatible with other high-performance TTL logic products, but offer superior performance levels not found elsewhere.

### Immediate availability

You don't have wait to break the speed barrier. The FCT-C family of TTL logic is available today in high-density SOIC packages for improved packaging density. Plastic and hermetic DIP, LCC, and Cerpack packages will be available in late 1989.

### You can count on us

We'd like to tell you more about how you can use FCT-C TTL logic to improve your system speed. Call (408) 492-8550 today for more information on FCT-C logic. Or call (408) 492-8225 for your copy of the FCT data sheets and the 1989 IDT Data Book Supplement with details about our current line of CMOS products.

IDT offers a full range of other high-performance building blocks including RISC processors, SRAMs, multi-port and FIFO memories, standard and complex logic, and RISC subsystems and modules.

IDT, P.O. Box 58015, 3236 Scott Blvd., Santa Clara, CA 95052-8015, FAX 408-492-8674.

*When cost-effective performance counts*



**Integrated  
Device Technology**



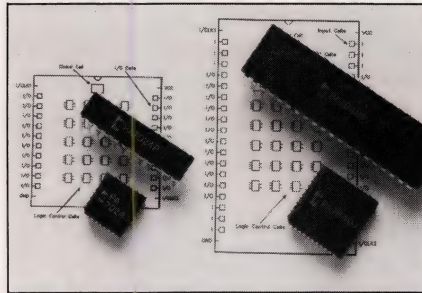
# Integrated Circuits

## Programmable device combines features of PLDs and PGAs

The PA7024 is the first member of a CMOS programmable-device family, PEEL (programmable electrically erasable logic) arrays, that combines elements of both PLDs and programmable gate arrays. The foundation of the PA7024 is its logic-control cell (LCC).

Each LCC has four primary input lines and produces two independent output signals. LCCs contain registers that can operate as synchronous or asynchronous D, T, or JK flip-flops. The input signals for each LCC are four of 80 possible sum-of-product terms, which you select by programming.

The four input signals can be used as data for the register or to clock and control the register. An LCC's two output signals are selectable from three of its input signals or



the register's output signal. One output of each LCC connects to an I/O cell, and the other is available for creating the sum-of-product terms.

The PA7024 has 20 I/O pins and two dedicated clock-input pins. Internal to the device are 20 LCCs, 20 I/O cells, and a global cell interconnected through a programmable-logic matrix. The device lets you define signals in PLD-like sum-

of-product terms; but, as with gate arrays, creating internally used signals does not force you to sacrifice an I/O pin.

The global cell controls the selection and routing of clock signals to both the I/O cells and the LCCs. This cell can treat all cells as a single group with a common set of clocks or divide them into two independent groups. The internal clocks can operate as fast as 50 MHz. The propagation delay from one I/O pin through an LCC to another I/O pin is 23 nsec. The PA7024 costs \$22.50 (100).

**International CMOS Technology Inc., 2125 Lundy Ave, San Jose, CA 95131. Phone (408) 434-0678. TWX 910-997-1531.**

Circle No 453

## A/D converter uses sigma-delta modulation to resolve 16 bits at 100 kHz

The DSP56ADC16 100-kHz, 16-bit A/D converter implements sigma-delta modulation technology on a single chip. The sigma-delta conversion technique's inherent filtering eliminates the need for external filtering. This conversion process also has inherent oversampling and noise-shaping capabilities, which enable the converter to exhibit 90-dB signal-to-noise and signal-to-THD ratios for input signals of 0 to 45.5 kHz with an in-band ripple of less than 0.001 dB. In addition to the 16-bit output, the ADC's architecture lets you select an inter-

mediate filter output to obtain 12 bits of resolution at 400 kHz.

The DSP56ADC16 oversamples the incoming data at 64 times the output sampling rate, or 6.4M samples/sec. The converter's third-order noise-shaping curve and its associated 18 dB/octave slope ensure that very little of the noise power remains in the passband.

The ADC implements the digital lowpass filters in two stages: A comb filter performs 16:1 decimation on the modulator output, and a FIR filter performs 4:1 decimation on the comb-filter output. You can

connect the output of either of these two filters to the device's serial output to achieve a 16-bit, 100-kHz output or a 12-bit, 400-kHz output.

The DSP56ADC16 operates from one 5V supply and nominally draws 30 mA. The device is available in 20-pin ceramic DIPs and in plastic and surface-mount packages for \$25 (100).

**Motorola Inc., Microprocessor Products Group, 6501 William Cannon Dr W, Austin, TX 78735. Phone (512) 440-2039.**

Circle No 454

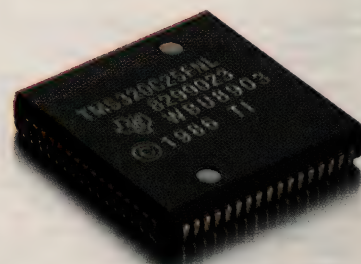




**The ADSP-2100.**

- The ADSP-2100 computes a 1024-point complex FFT in less than 3 ms with a total memory requirement of less than 4k bytes. It also computes a  $2 \times 2$ D convolution in 1.2  $\mu$ s and executes ADPCM in only 68  $\mu$ s.
- The ADSP-2100 can access two words of external data every cycle.
- The ADSP-2100 supports zero-overhead loops of any length. So our looped code – which is the easiest to write – is also the fastest.
- The ADSP-2100's two dedicated data address generators can auto-increment/decrement by any offset value, and they have automatic circular buffer wraparound.
- The ADSP-2100 Assembler supports the easiest language in the business. So you code a multiplication/accumulation the same way you'd write the original algorithm. For example, the algebraic  $R = R + X*Y$  codes as  $MR = MR + MX0*MY0$ .

Given  
enough  
time, the  
**TMS320C25**  
can do  
almost  
everything  
the  
**ADSP-2100**  
can.



**The TMS320C25.**

- The TMS320C25 takes more than three times as long to compute the same size FFT, while it devours over 47k bytes of memory.<sup>1</sup>
- The TMS320C25 is limited to one access of external data every two cycles.
- The only zero-overhead loop the TMS320C25 can execute is one instruction repeated no more than 256 times.
- Circular buffers? The TMS320C25 doesn't support them.
- The TMS320C25 is programmed with 133 mnemonics like SPAC, BGEZ, MACD, XORX, and SBRK. A multiplication/accumulation is coded as  $MACD > FF03, * -$ . While this might not scare the XORX out of you, it's not the easiest thing to debug or maintain.

We're not saying the TMS320C25 is slow. But even if it were twice as efficient as it is now, it'd still be a lot slower at DSP than the ADSP-2100. The fact is, the ADSP-2100 is out in front of the TMS320C25 in performance, readability of code, and development tools.

Just how far out front? Get our free technical booklet and read about it. Or better yet, get an ADSP-2100 sample kit for only \$49.95 and see for yourself. To request either, call DSP Marketing at 1-617-461-3771.



Analog Devices, Inc., One Technology Way, P.O. Box 9106, Norwood, MA 02062-9106; Headquarters: (617) 329-4700; California: (714) 641-9391, (619) 268-4621, (408) 559-2037; Colorado: (719) 590-9952; Maryland: (301) 992-1994; Ohio: (614) 764-8795; Pennsylvania: (215) 643-7790; Texas: (214) 231-5094; Washington: (206) 575-6344; Austria: (222) 885504-0; Belgium: (3) 237 1672; Denmark: (2) 845800; France: (1) 4666-25-25; Holland: (1620) 81500; Israel: (052) 911415; Italy: (2) 6883831, (2) 6883832, (2) 6883833; Japan: (3) 263-6826; Sweden: (8) 282740; Switzerland: (22) 31 57 60; United Kingdom: (932) 232222; West Germany: (89) 570050.

<sup>1</sup>EDN, "EDN's DSP Benchmarks," September 29, 1988.



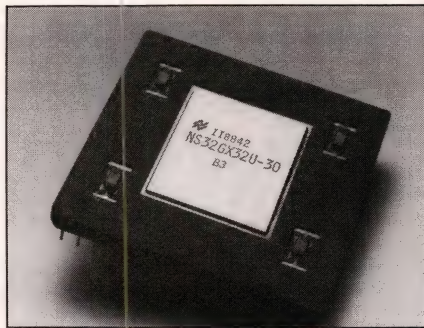
# Integrated Circuits

## 32-bit embedded processor drives printers and imagers

Featuring a peak performance of 15 MIPS with no wait states at a frequency of 33 MHz, the NS32GX32 is a 32-bit embedded system processor that is software compatible with the vendor's 32000 series products.

The architecture of the NS32GX32 provides on-chip bit-block-transfer instruction primitives and logic; stack instruction syntax tuned for PostScript execution; and an on-chip, 2-way, set-associative 1k-byte data cache for character generation.

A 4-stage instruction pipeline enhances system performance by allowing multiple simultaneous instruction execution. With the pipeline, the processor can fetch one instruction, read the source operand of a second, calculate the results of



a third, and store the results of a fourth.

Unless the pipeline is broken by a jump or branch, this simultaneous-execution capability improves the performance of the processor. The NS32GX32 features branch prediction that works to minimize the penalty of a broken pipeline by reacting to a decoded branch in-

struction before it is executed. The reaction mechanism, with a few exceptions, is that backward branches are taken and forward branches are not taken.

The 32-bit embedded processor also provides an on-chip 512-byte instruction cache; a variable-bus-sizing feature that supports 8-, 16-, or 32-bit wide memories; and a floating-point support for the NS32381. The NS32GX32 is available in a 175-pin pin-grid-array package, and the 20-MHz version costs \$99 (1000).

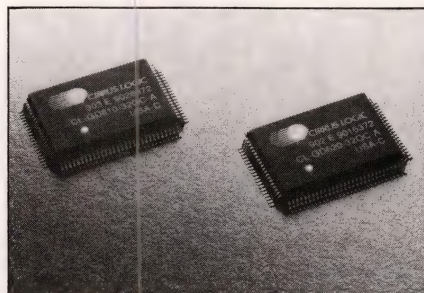
**National Semiconductor Corp., Box 58090, Santa Clara, CA 95052. Phone (408) 721-2838. TWX 910-339-9240. TLX 346353.**

Circle No 455

## Chip set delivers VGA graphics to liquid-crystal-display panels

Using a patent-pending algorithm to map the VGA (video graphics adapter) standard palette of 256 colors to 32 shades of gray, The GD610/620 VGA-controller chip set provides high-quality CRT-display images to liquid-crystal-display (LCD) panels. The chip set offers full hardware compatibility to many LCD panels as well as electroluminescent and gas-plasma panels and CRT terminals.

The chip set uses a sum-to-gray-scale color-conversion algorithm and an on-chip color-palette memory for consistent color mapping. An automatic scaling technique converts the various pixel formats of the different display standards into the fixed LCD format of either 640x400 or 640x480 pixels. Using



this technique, the GD610/620 retains full compatibility with its graphics predecessors, like the VGA, EGA, CGA, HCG, and MDA standards. Additionally, automatic scaling has three modes: a compression mode, a compatibility mode, and an expanded mode.

Another feature of the GD610/620 chip set is low power consumption.

Typical operating power consumption is 2.5 to 3W if your design uses pseudostatic RAMs and 3.5 to 4W if it uses dynamic RAMs. In standby mode, the chip dissipates 1.5 to 2W.

The chip set operates at 33 MHz and works with both high-resolution variable frequency and IBM PS/2 analog monitors. Refresh rates as high as 160 Hz provide high contrast and reduced flicker with dual-line, dual-panel, 400- or 480-scan-line LCD panels. The set costs \$52.50 (100) in dual, 100-pin quad flat packs.

**Cirrus Logic Inc, 1463 Centre Pointe Dr, Milpitas, CA 95035. Phone (408) 945-8300. FAX 408-263-5682. TLX 171918.**

Circle No 456



Dual-port RAM SAE 81C80A

## The fast data despatch station

### The problem:

Multicontroller systems need a simple, fast, inexpensive but tailored means of communication if they are to really show what they are capable of. In other words, data flow between two microcontrollers or microprocessors without queuing times.

### And the solution:

The SAE 81C80A dual-port RAM from Siemens with the kind of features that produce entirely new dimensions in such an application:

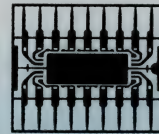
- Fully static CMOS RAM with 504 x 8 bits
- Eight reservation registers for straightforward handling of large and contiguous data blocks
- Compatible with 8048/51/515/96, 8088 and 80188

- Asynchronous working of both controllers or processors
- Defined status upon simultaneous accessing of a memory location, when writing too
- Three extra loadable counters as processor monitors (watchdog) or longterm counters
- TTL-compatible
- Extended temperature range from -40 through + 85°C

All of this makes the SAE 81C80A dual-port RAM from Siemens the ideal, high-speed database for linking two controllers/processors with different tasks.

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simulated in systems context.

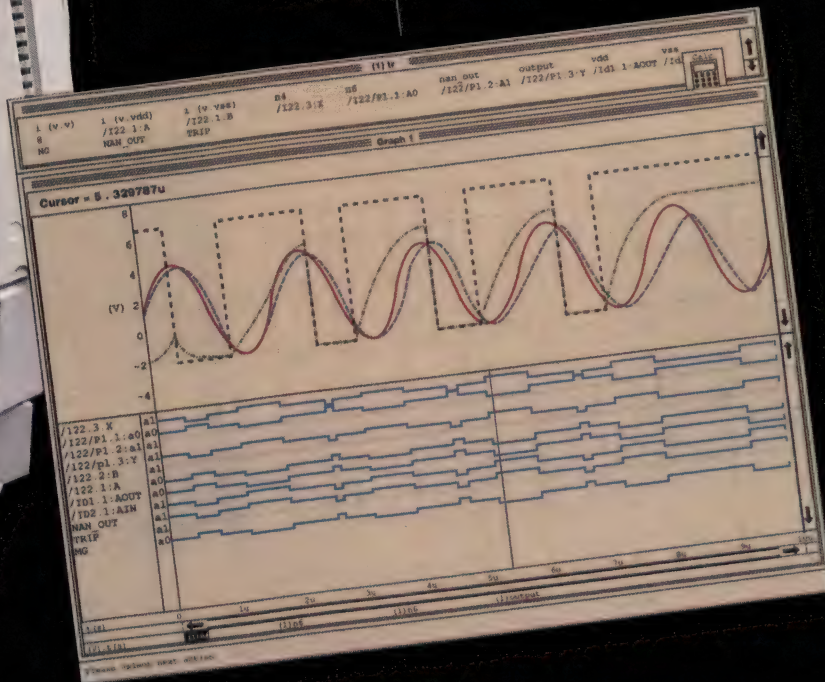


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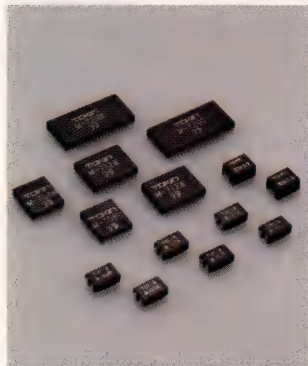


# Quietly Behind Miniaturization TOKIN EMC Filters



From laptop computers to video cameras to fax machines, the demand for compact electronic equipment has never been so great. And this is just the beginning.

This unceasing miniaturization has had a profound influence on circuit design, to the extent that circuits are getting smaller, thinner and ever-more-highly integrated.



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Backed by our long string of EMC Breakthroughs, TOKIN is meeting this demand with an incomparable line of high-quality EMC Data Line Filters. From compact surface-mount EMC Chip Filters (including 3 mm chip filters [as thin as LSIs] for half-pitches and SN chips for high impedance noise) to DIP Noise Filters for high impulse impedance over a

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equipment manufacturers in the world—TOKIN realizes the need for precise countermeasures to noise in portable electronic equipment. That's why our customers recognize the need for TOKIN.

Find out how TOKIN can help you take excess pounds and inches off of your electronic products. Call us now.

Model	Frequency range (MHz)	Impedance ( $\Omega$ )	
M-608□	5 ~ 200	$\geq 300$ (at 100MHz)	Common mode
M-614□	5 ~ 100	$\geq 700$ (at 50MHz)	Common mode
M-620□	5 ~ 50	$\geq 1000$ (at 300MHz)	Common mode
M-720N	50 ~ 300	$\geq 100$ (at 200MHz)	Normal mode 20 circuits
M-712N	50 ~ 300	$\geq 100$ (at 200MHz)	Normal mode 12 circuits
M-708N	50 ~ 300	$\geq 100$ (at 200MHz)	Normal mode 8 circuits
M-720C	50 ~ 300	$\geq 70$ (at 200MHz)	Common mode 2 circuits x 10
M-712	50 ~ 300	$\geq 70$ (at 200MHz)	Common mode 2 circuits x 6
M-708C	50 ~ 300	$\geq 70$ (at 200MHz)	Common mode 2 circuits x 4
M-540C	5 ~ 200	$\geq 370$ (at 50MHz)	Common mode 4 circuits
M-580C	5 ~ 200	$\geq 370$ (at 50MHz)	Common mode 4 circuits x 2

□ indicates stick types (25 pcs per stick type)

□ indicates reel types (1,500 pcs per reel) (16x8mm pitch, 13" reel) □ indicates loose types (100 pcs per bag)

Model	Rated current (A)	Inductance Min. ( $\mu$ H)	DC Resistance Max. (m $\Omega$ )	Operating temperature ( $^{\circ}$ C)
SN-S3M-1503□	1.5	3.0	60	-25 ~ +60
SN-S3M-1006□	1.0	6.0	100	-25 ~ +60
SN-S3M-0513□	0.5	13.0	500	-25 ~ +60

□ indicates reel types 1,000 pcs per reel (16x12mm pitch) □ indicates loose types 100 pcs per bag 13" reel

## TOKIN

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Hazama Bldg., 5-8, Kita-Aoyama 2-chome, Minato-ku, Tokyo 107, Japan  
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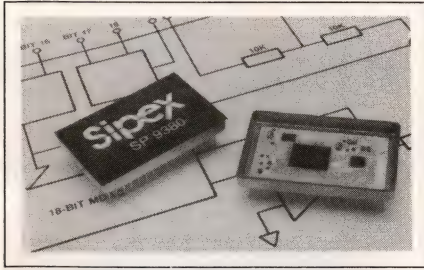
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# Integrated Circuits



## D/A CONVERTER

The SP9380 18-bit D/A converter uses a stable thin-film resistor process and a digitally decoded switching architecture to provide  $\frac{1}{2}$  LSB accuracy for both differential and integral linearity. The SP9380 contains a precision reference, input data latches, and an output amplifier. Voltage-output settling time to 0.00019% is 30  $\mu$ sec for a 10V step and 50  $\mu$ sec for a 20V step. Analog output-voltage ranges are pin programmable for 0 to 5V, 0 to 10V,  $\pm 5$ V, and  $\pm 10$ V. Differential non-linearity stability is 1 ppm/1000 hours at 25°C and 16 ppm/168 hours at 125°C. The SP9380 operates from  $\pm 15$ V supplies and is packaged in a 32-pin hermetic triple-DIP. Four product grades are available. \$200 to \$475 (100).

**Sipex Corp., Hybrid Systems Div., 22 Linnell Circle, Billerica, MA 01821. Phone (508) 667-8700. FAX 508-667-8310.**

Circle No 544

## MOS POWER BOOSTER

The PB50 200V MOSFET power booster delivers 2A continuous output current. The power booster runs on 17-mA typ quiescent current and can slew at 50V/ $\mu$ sec min, with a typical slew rate exceeding 100V/ $\mu$ sec. The PB50 has a guaranteed power bandwidth of 160 kHz with output signals of 100V p-p, or more than 80 kHz at 180V p-p. The PB50 contains an internal gain-set and feedback resistor, and you can program the booster for a gain of 3 by tying two pins together. Using a single external gain-set resistor, you can program the PB50 for gains

as high as 25. You can compensate the composite amplifier with one capacitor; however, it will be stable with most driver op amps and in most gain configurations without external compensation. You use one resistor to limit current. \$49.50 (100). Delivery, four to eight weeks ARO.

**Apex Microtechnology Corp., 5980 N Shannon Rd, Tucson, AZ 85741. Phone (800) 421-1865.**

Circle No 545

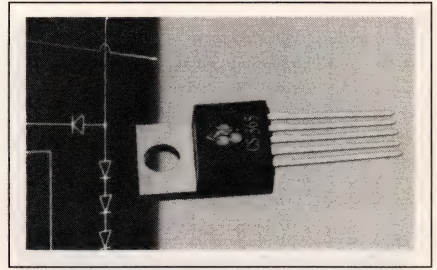


## SAMPLING ADC

Suited to high-performance signal-processing applications, the ADC603 hybrid A/D converter offers a resolution of 12 bits. At a 10-MHz sampling rate, the ADC features a typical differential non-linearity of 0.4 LSB and a maximum nonlinearity of 1 LSB. Other specifications include an S/N ratio of 68.2 dB at 5 MHz, an input analog bandwidth of 70 MHz, and 2-tone distortion products of -77.7 dB. The ADC603 contains an S/H circuit, a 2-step subranging ADC, a voltage reference, and circuitry for timing and error correction. The ADC603 is available in both commercial and military temperature ranges and is packaged in a 46-pin, hermetic ceramic/metal DIP. \$950 (500).

**Burr-Brown Corp., Box 11400, Tucson, AZ 85734. Phone (602) 746-1111.**

Circle No 546



## POWER OP AMP

Operating from a  $\pm 6$  to  $\pm 18$ V supply, the CS-365 power op amp has an open-loop gain of 80 dB typ, a slew rate of 8V/ $\mu$ sec typ, and an output-current rating of 3A max. Other specs include a typical input noise of 2  $\mu$ V from 10 Hz to 10 kHz and common-mode rejection of 70 dB. The CS-365 includes on-chip thermal-shutdown and safe-operating-area protection. In addition to its use in motor-control and power-supply applications, the CS-365 can deliver 18W into a 4 $\Omega$  load when used as an audio amplifier. The op amp comes in a 5-lead TO-220 package. \$1.44 (1000).

**Cherry Semiconductor Corp., 2000 S County Trail, E Greenwich, RI 02818. Phone (401) 885-3600.**

Circle No 547

## BIPOLAR OP AMP

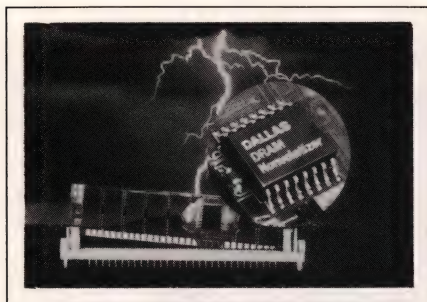
Suited to video applications and high-speed data-acquisition systems, the HFA-0002 bipolar op amp offers a gain bandwidth of 1 GHz and a slew rate of 150V/ $\mu$ sec. The op amp also features an offset voltage of 0.7 mV and a high gain of 80V/mV. The HFA-0002 is available in an 8-lead TO-99 metal package, an 8-pin side-brazed ceramic DIP, or an 8-pin plastic DIP. The metal and ceramic packages operate over commercial, industrial, and military temperature ranges. The plastic package is specified for commercial and industrial use. \$7.05 to \$38.15 (100).

**Harris Corp., 1025 W Nasa Blvd, Melbourne, FL 32919. Phone (407) 724-7800.**

Circle No 548



# Integrated Circuits



## DRAM CONTROLLER

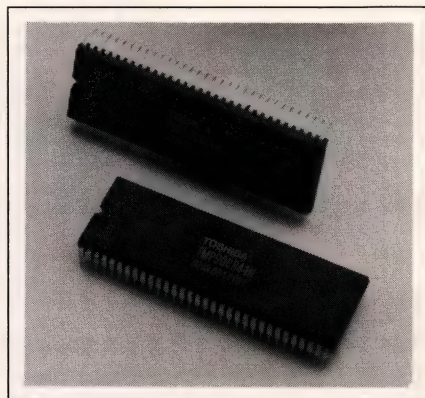
The DS1237 DRAM Nonvolatizer is an IC in a 16-pin small-outline package. The DRAM Nonvolatizer switches control of your memory's power-supply needs to a backup energy source during power outages and manages the dynamic RAM (DRAM) refresh that maintains memory. As the chip switches power sources, it intercepts system signals to prevent data destruction while the power is below or above acceptable levels. A hand-off procedure protects data when the main

power returns.

The chip contains a regulator to ensure that the voltages supplied to your memories are within acceptable levels. You can use supplementary power from capacitors, rechargeable NiCd batteries, or long-life lithium batteries. To monitor or examine the condition on your secondary power supply, the chip contains a provision to report the remaining charge available to the computer after the power returns. According to the vendor, a small lithium battery can supply power to the DRAM Nonvolatizer for approximately two weeks. DS1237, \$7; DS2219, in a 9M-bit, 120-nsec RAS access-time subassembly, \$288 (100).

**Dallas Semiconductor, 4350 Beltwood Pkwy S, Dallas, TX 75244. Phone (214) 450-0400. FAX 214-450-0470.**

Circle No 549



## MICROCONTROLLER

The TMP90C840 combines an 8-bit central-processing unit (CPU) with 8k bytes of ROM, 256 bytes of RAM, an 8-bit A/D converter, a multifunction 16-bit timer/counter, I/O ports, and a serial interface. Managed by an 11-channel direct-memory-access controller, external program memory can reach 56k bytes and external data memory can reach 1M byte. The device fea-

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The new chip connects directly to the computer bus with no additional ICs. It can be controlled from the main system CPU, eliminating the need for a separate modem controller and support circuitry. It provides the designer with all the modem functions required for worldwide operation at 300, 600, and 1200 BPS rates for Bell and CCITT standards. And the UART is compatible with industry standard 8250A/16C450 devices used with MS-DOS products. It can also be used independently of the modem function. All of this modem/UART capability is packed into a device that operates from a single +5V supply at very low power.

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Circle 130 for Product Information



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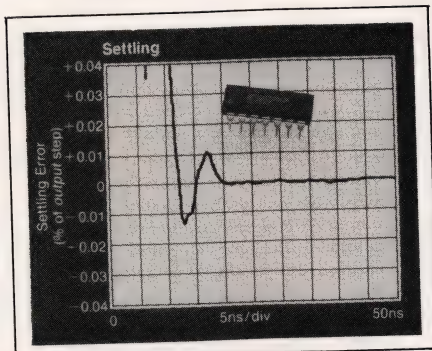
tures 163 basic instructions, including 16-bit arithmetic operations. It has a minimum instruction execution time of 400 nsec with a 10-MHz clock. The CMOS device operates from a single 5V supply and dissipates 250 mW. It comes in a plastic DIP or a quad flat pack. \$9.50 (5000).

**Toshiba America Inc, 9775 Toledo Way, Irvine, CA 92718. Phone (714) 455-2000.**

Circle No 550

## FAST-SETTLING OP AMP

The CLC500 is a 150-MHz operational amplifier that settles to 12 bits (0.01%—1/2 LSB) in 25 nsec overtemperature. A patented current-feedback architecture minimizes the dependence of settling time on gain settling. An output clamping feature lets you set maximum positive and negative output-



voltage levels for the amplifier so that it can protect delicate converter systems from destructive transients or other saturating signals. Additionally, the CLC500 has a 10-nsec overload recovery time, so normal operation resumes quickly after overdrive. The harmonic distortion performance of the CLC500 is better than -80 dB at 5 MHz for loads  $>500 \Omega$ . The input-referred noise is only  $40 \mu V_{rms}$ . Industrial-temperature-range, 14-pin plastic DIP, \$17.35; industrial-

temperature-range, 14-pin hermetic side-brazed ceramic DIP, \$27.75; military-temperature-range, 14-pin sidebrazed ceramic DIP, \$43.30 (100).

**Comlinear Corp, 4800 Wheaton Dr, Fort Collins, CO 80525. Phone (303) 226-0500. FAX 303-226-0564. TLX 450881.**

Circle No 551

## 2M-BIT MEMORIES

Available in 32-pin DIPs with JEDEC (Joint Electron Device Engineering Council) standard pin-outs, the WS-256K8-120 and WE-256K8-150 are organized as 256x8 static RAM (SRAM) and EEPROM, respectively. Both devices are CMOS and sport CMOS- and TTL-compatible inputs and outputs. Operating power consumption for the SRAM at 25°C and 5 MHz

Text continued on pg 140









# A 40¢ component can stop what nature throws at you.

Every so often, nature throws your system a surge. And whether it's lightning, static or a simple crossed line, it can destroy the most expensive system with a single blow.

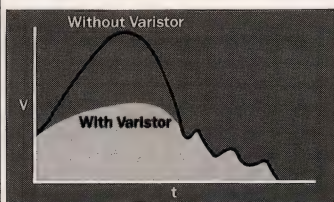
About 40¢ is all it takes to protect your design from this cruel fate. Thanks to the full line of surge suppression devices from Harris.

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Harris offers the broadest line of MOVs in the industry. From 5V to 3500V. Up to 70,000 peak amps. And up to 10,000 joules.



They're widely used for incoming AC protection and clamping circuits. And they're available in a wide range of packaging—axial leaded, radial leaded, leadless surface mount, high-energy modules and connector-pin configurations.

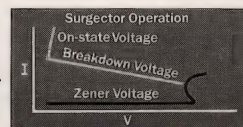
## Inventor of Surgector.

Surgector devices combine a thyristor and a zener into one reliable cost-effective device. At low voltages the Surgector device is off. But the

instant its clamping voltage is exceeded, the Surgector turns on. Within nanoseconds, the surge is shunted safely to ground, protecting your circuit from sure destruction.

Because Surgector devices respond so quickly and can shunt lots of energy away from the circuit, they're

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AMC 240



# ED AHEAD.

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It runs at full target clock speed—33 MHz for 68020 and 68030. It fully supports 68030 cache burst and synchronous bus cycles. And, since it sits as a node right on the trunk of your Ethernet network, the EL 3200 can be accessed from any workstation.

The EL 3200 offers your choice of source level or symbolic debugging. Whether you want to work in Assembly or C, we can provide the software tools for your exact needs.

The sophisticated breakpoint system has hundreds of real-time access breakpoints, six real-time execution breakpoints and unlimited software execution breakpoints. As an option, you can have up 2MB of no wait state overlay memory that runs at full clock speed, so there are no restrictions on memory, software or interrupts. The 16K deep by 139 bit wide trace provides true 32 bit support.

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Applied Microsystems Corporation, P.O. Box 97002, Redmond, Washington, USA 98073-9702.

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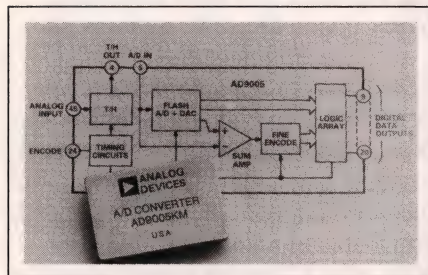
# Integrated Circuits

is 33 mA; for the EEPROM, it is 60 to 70 mA. In standby mode, the SRAM typically consumes 1.8 mA, and the EEPROM consumes 1.1 mA.

The ICs have been designed and manufactured for hostile environments; the ceramic packages feature a welded metal cover and cofired construction. The SRAM retains data at voltages as low as 2V, and internal power-supply bypass capacitors enhance chip performance. Read-and write-cycle access times for the SRAM are 120 nsec. The EEPROM has a read access time of 150 nsec and lets you write a page in 3 msec max. The EEPROM uses the chip's 5V supply for data programming and features 10-year data retention. SRAM, \$275; EEPROM, \$2280 (100) for military versions.

**White Technology Inc, 4246 E Wood St, Phoenix, AZ 85040. Phone (602) 437-1520. TWX 910-951-4203.**

Circle No 552



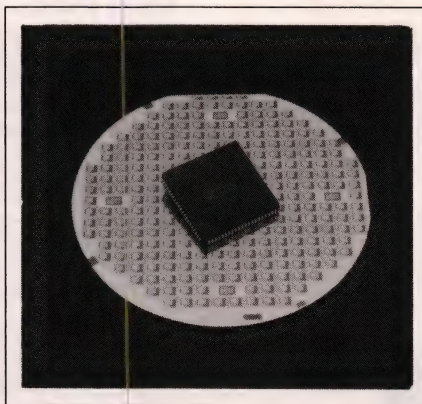
## 12-BIT A/D CONVERTER

Available in a 46-pin package, the AD9005 is a complete 12-bit hybrid A/D converter (ADC) that dissipates 3.4W of power—33 to 50% less than competitive versions, according to the manufacturer. The AD9005 features an onboard track-and-hold amplifier, a voltage reference, TTL timing circuitry, and output latches. The ADC uses a subranging architecture that samples inputs to 10M samples/sec. It also has a maximum transient response of 120 nsec and an overvoltage recovery time of 150 nsec at

25°C. Differential nonlinearity and integral nonlinearity are  $\frac{3}{4}$  LSB and 2 LSB, respectively. With a frequency input of 4.3 MHz, in-band harmonics are -66 dB min, and S/N ratio is -61 dB min. The AD9005 is available in commercial and military grades. \$800 and \$1400 (100).

**Analog Devices, Literature Center, 70 Shawmut Rd, Canton, MA 02021. Phone (617) 935-5565.**

Circle No 553

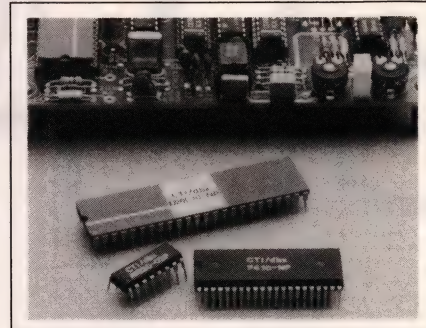


## LAN CONTROLLER

A third-generation ArcNet controller, the COM90C65 provides highly integrated support for IBM PC-based LANs. The COM90C65 combines the controller, the transceiver, and the support logic required to interface ArcNet to the IBM PC bus. The controller contains a programmed sequencer and all the logic necessary to control the token-passing mechanism on the network and send and receive data packets at the appropriate time. You can connect a maximum of 255 nodes to the network, with each node assigned a unique ID. The COM90C65 establishes the network configuration and automatically reconfigures the token-passing order as new nodes are added to, or deleted from the network. 84-pin plastic leaded-chip carrier, \$17.50 (5000).

**Standard Microsystems Corp, 35 Marcus Blvd, Hauppauge, NY 11788. Phone (516) 273-3100.**

Circle No 554



## AUDIO ADC CHIP SET

The F410/D20C10/A1520 A/D converter chip set is designed for high-performance audio applications. It consists of the F410 front-end IC, the D20C10 20-bit decimator, and the A1520 precision resistor network. The ADC uses noise-shaped oversampling at 6 MHz and flash, 4-bit conversion. The D20C10 is a digital filter with a 6-bit input and a 20-bit output; it has a 128:1 ratio of input-to-output sample rates. The A1520 contains 15 matched, 20-kΩ resistors. It works in conjunction with the F410 and two 8-bit flip-flops to form the complete A/D converter. The basic chip set features 18-bit resolution, a signal-to-noise ratio of 105 dB, <0.005% THD at maximum output, and differential linearity of 0.000000076%.

For 20-bit resolution, a second F410 and A1520 are required. \$130 (100).

**CTI Research, 71 Chapel St, Newton, MA 02195. Phone (617) 964-3210.**

Circle No 555

## 3-BIT SINK DRIVER

The UCN5929B is a 3-bit serial-input, latched smart-power IC that merges low-power CMOS logic with high-power bipolar output drivers. The IC features three diode-clamped, open-collector npn output drivers that can sink as much as 1.7A continuous and sustaining load voltages to 80V. The UCN5929B also incorporates a 3-bit, externally clocked shift register and an externally strobed CMOS data latch for each driver; this combination sup-



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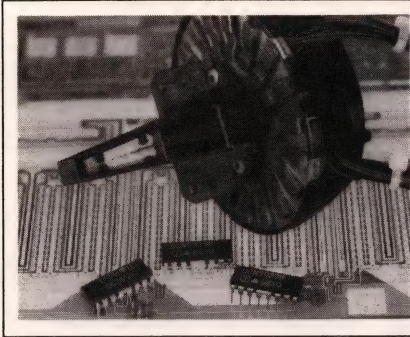


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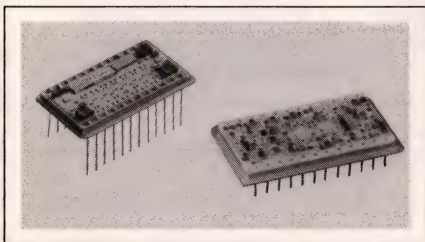


ports both serial and parallel data output. High-current clamping diodes on each output driver and internal thermal shutdown circuitry that turns off the drivers at a junction temperature of 165°C protect the IC from potentially damaging conditions.

To simplify the interfacing of the sink driver with its host controller, the UCN5929B has CMOS-compatible Clock, Serial Data In, Serial Data Out, and Strobe signals for external control over the latch-to-driver transfers. The chip can operate at clock rates to 3.3 MHz and comes in a power-tabbed 16-pin DIP with copper lead frames. When you operate the device within the specifications and with duty cycles below 40%, you don't need a heat sink. The chip draws between 1.5 mA (with all outputs off) and 8 mA (with all outputs on). \$2.21 (1000).

**Sprague Semiconductor Group, Box 15036, Worcester, MA 01615. Phone (508) 853-5000.**

Circle No 556



## 12-BIT DAC

The DAC-02315 D/A converter and the DAC-02316 track-and-hold deglitcher have a 35-MHz update rate and a full-scale settling time of 50 nsec. The D/A converter gen-

erates digitally controlled, binary-weighted analog-output currents. Bipolar transistor switches that the digital input code turns on and off control a ladder network of thin-film precision resistors. The track-and-hold deglitcher contains—in simple terms—a capacitor, a switch, some buffers, and ECL. Through control of the switch, the logic determines whether the capacitor and output voltage track the input signal—switch closed—or retain the value of the input at the moment the switch opens.

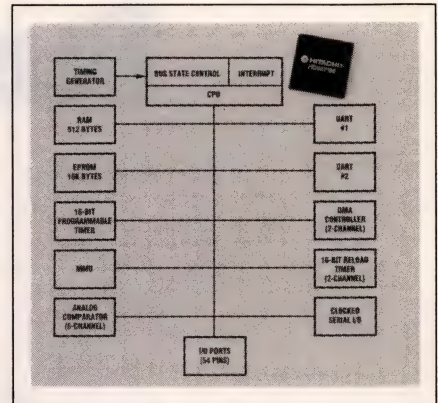
The deglitcher limits output glitch amplitudes to 14 mV peak-to-peak and duration to under 38 nsec. The devices are ECL compatible and have an operating temperature range of -55 to +125°C. Also available is a full-function evaluation card that contains the two hybrids, TTL/ECL translators, input latches, trimmers, and distributed capacitors to optimize glitch and settling time characteristics. D/A converter, from \$189; track-and-hold deglitcher, from \$369.

**ILC Data Device Corp, 105 Wilbur Pl, Bohemia, NY 11716. Phone (516) 563-5678. FAX 516-567-7358.**

Circle No 557

## MICROCONTROLLER

The HD647180X is an 8-bit microcontroller that benefits from the Z80 architecture. Although the microcontroller uses a superset of the Z80 instruction set, it can directly execute older Z80 programs, and the chip processes instructions in 375 nsec. The additional instructions added to the HD647180X include special I/O instructions, a hardware multiple, and an instruction to put the chip into a low-power standby mode. In addition to instruction augmentation, the chip has several performance enhancements. Memory access is a 3-cycle process, unlike the Z80's 4-cycle process, and the integration of a



number of peripheral functions on chip reduces timing constraints imposed by having to run signals between chips. Real-estate requirements are also reduced as a result of this integration. The on-chip peripheral functions include a memory-management unit (MMU), 2 UARTs, a 2-channel DMA controller, 512 bytes of RAM, 16k bytes of one-time-programmable EPROM, three 16-bit programmable timer channels, and I/O ports (54 bits). The chip runs at 8 MHz. 80-pin quad flat pack, \$17.70; 84-pin PLCC, \$19.10 (1000).

**Hitachi America Ltd, 2000 Sierra Point Pkwy, Brisbane, CA 94005. Phone (415) 244-7159. FAX 415-583-4207.**

Circle No 558

## ANALOG GRAB BAG

The 29-1000 is an analog IC that offers a host of uncommitted functions in a single package (a 40-pin ceramic DIP or a 44-pin LCC). The chip contains a programmable current source that can provide 1 to 10 mA; a programmable voltage source that offers 0.1 to 4V; a 3V bandgap reference source; a non-linear function (AB/C); an exponential function ( $D^E$ ); a gain-programmable differential instrumentation amplifier; a utility operational amplifier; two comparators; and a programmable 4- to 20-mA current loop transmitter. The IC operates from one 5V supply at an operating temperature range of -40 to



# Integrated Circuits

+80°C. Quiescent current is 22 mA, and typical device accuracy is  $\pm 0.1\%$ . An evaluation pc-board kit for the 29-1000 is also available. The kit has provisions for resistors; capacitors; potentiometers; transistors; diodes; 8-, 16-, and 40-pin DIPs; voltage regulators; LEDs; and LCDs. \$49.

**International Microtronics Corp., 4016 E Tennessee St, Tucson, AZ 85714. Phone (800) 433-3767. FAX 602-790-2808.**

Circle No 559

## ANALOG SWITCHES

Fabricated in DMOS/CMOS technology, the DG540, DG541, and DG542 analog switches are TTL compatible and feature bandwidths to 500 MHz. Available in dual and quad versions, the devices provide 5 MHz off-isolation to -80 dB and crosstalk of -85 dB. The quad

DG540 and DG541 are both spst switches. The DG541 comes in a 16-pin package. The 20-pin DG540 includes extra ground lines between the signal pins to improve off-isolation and reduce crosstalk. The dual DG542, which also comes in a 16-pin package, has four analog switches configured as two spdt functions. You can use each spdt switch as a selector between two channels, allowing the DG542 to handle two sets of video signals simultaneously. \$3.93 to \$15.83 (100).

**Siliconix Inc., 2201 Laurelwood Rd, Santa Clara, CA 95054. Phone (408) 988-8000.**

Circle No 560

## PIN DRIVER

The EL2021 monolithic pin driver is suitable for loaded board testing as well as linear or logic bench-top testers. The device can overpower

logic outputs and accurately drive independently set high and low levels that have programmed slew rates. The vendor provides dc output levels within 50 mV at a 100-mA load and within 300 mV at a 400-mA load. The EL2021 also has a 3-state capability, allowing you to put the outputs into a high-impedance state for load monitoring. The slew rate is  $100\text{V}/\mu\text{sec} \pm 20\%$  with a slew-rate control input of 1V and typically offers a  $300\text{V}/\mu\text{sec}$  slew rate at higher control levels. To conserve energy, you can shut down the EL2021 when it's not in use. Typical quiescent power falls from 625 to 15 mW when you operate the device with supplies at 15V and -10V. EL2021CJ in an 18-pin ceramic DIP, \$35 (100).

**Elantec Inc., 1996 Tarob Ct, Milpitas, CA 95035. Phone (408) 945-1323.**

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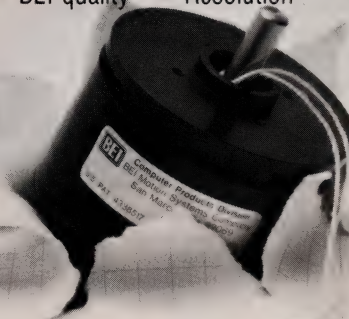
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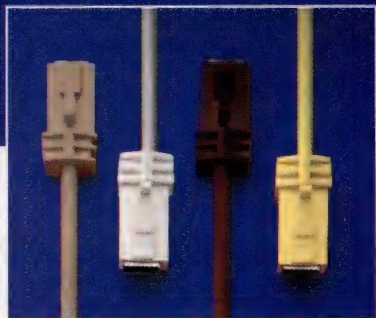
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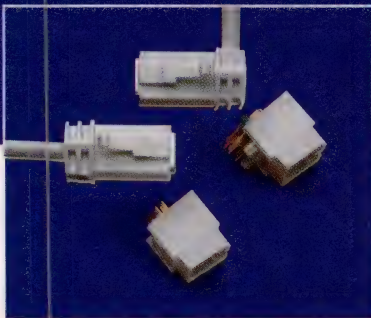
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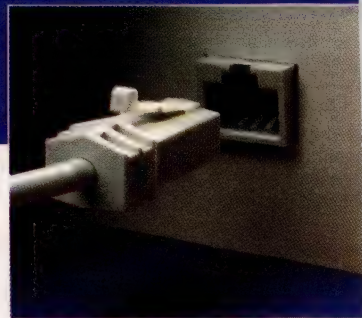




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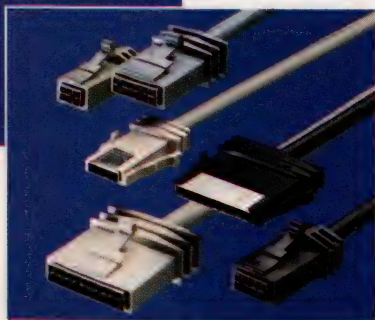
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# Prototyping techniques evolve to match design complexities

**By testing your designs with some nontraditional prototyping techniques, you can satisfy that ever-present need to make sure your circuit works before committing to silicon.**

J D Mosley,  
Regional Editor

**A**s the complexity of electronic circuits increases, prototyping techniques become more critical, and getting a sound prototype becomes more difficult. And in order to remain competitive in today's global markets, engineers find that they must shorten design cycles while improving product quality. Accordingly, novel ways to prototype have emerged, including solderless breadboarding, off-site prototype manufacturing, computer-aided prototyping machines, and circuit-emulation programs. Each has advantages and problems.

The widespread use of CAE programs has provided an efficient means for engineers to develop the schematics for complex, multilayered circuits. However, once such

schematics exist, the engineer must somehow translate those colorfully plotted markings into operational hardware for debugging and testing purposes. Traditionally, wire wrapping and breadboarding could satisfy most prototyping requirements and provide you with a functional facsimile of your design. But as the density and operating frequency of your circuit increase, the probability of electrical and mechanical infidelity in point-to-point prototypes becomes greater.

If your design is relatively straightforward, breadboarding the circuit is still the quickest way to test your hardware. This is especially true if you use one of the latest offerings from 3M. The company's Powerace 203 is a solderless breadboard with an internal, triple-





output power supply; two logic monitors; a clock generator; data pulse sources; two logic-level switches; a pulse generator; and a pulse-detection circuit. A built-in power meter ranges from +15 to -15V dc, and you can remove the 203's Powerace-Plus circuit board, which provides 1680 connect points and an aluminum ground plane. For digital prototyping, you can purchase the Powerace 202 with three logic indicators, four data switches, and selectable frequencies ranging from 1 to 100 kHz. Both the 202 and 203 cost \$165, and the removable Powerace-Plus circuit boards retail for \$20 each.

If your design requires a prototype that offers strict mechanical and electrical fidelity, several pc-board manufacturers also offer pro-

totyping services—usually in hopes of gaining your business for the production run once the prototype passes muster. Of the approximately 1500 pc-board fabrication companies in the US, very few are eager to expand their prototype business, however.

The key to successfully working with an off-site board manufacturer lies in the sophistication of your CAE system and the quality of its output. Select a CAE program that lets you enter your schematic; generate a net list; lay out your board; route your traces; and produce descriptive data in Gerber format, which you can later transmit via a modem to any prototype shop in the country.

Once you've selected your CAE software, you must consider the im-

**A computer-aided prototyping machine (ProtoCAD)**



**As the density and operating frequency of your circuit increase, the probability of electrical and mechanical infidelity in point-to-point prototypes becomes greater.**

your computer's peripherals will have on the finished prototype. Your monitor's level of resolution can affect the manufacture of the board if the density of screen pixels prevents you from precisely locating your pads and traces. Your plotting system can also affect the quality of prototypes.

Although pen and laser plotters are readily available in most engineering facilities, and therefore offer a quick and inexpensive means of generating a hard copy of your circuit design, such devices limit your resolution to 10- or 12-mil lines. A vector plotter provides finer resolution, and most off-site manufacturers recommend that you send them photoplots of your circuit. Some photoplotters can provide resolution as fine as 3 to 4 mils.

Photoplotting, however, requires

design you thought you had created. Although a paper plot may look good, photoplotting is the next best thing to having the actual prototype in your hands. Particularly for complex designs, you'll waste time and money if you insist on not proofing your CAD output until the prototype stage.

#### **Don't do it yourself—and save**

Of course, the most significant factor that can affect the quality and manufacture of your board's design is your own familiarity with the CAD program and your skill as a draftsman. It can take as long as two to three man-years for a company to gain enough proficiency in CAD design to produce a working prototype on only the first or second submission to a prototype manufacturer. And besides the expense of training personnel to use the system, there is also the expense of purchasing all the necessary equipment. If you will be working with your CAD system on an infrequent basis or if your company plans to produce fewer than 24 different boards a year, doing the CAD designing in-house can cost more than sending your net list and layout sketch to a pc-board design service center.

One such center, National Design, guarantees a 1-week turnaround on digital circuit designs. The company promises to deliver a CAD design of your board, check plots, and photoplots within seven days, or the board is free. You'll pay a minimum of \$500 per board, with a typical IBM PC/AT-size board costing around \$2000 and a larger VME-size board going for \$3000 to \$4000. If you're in a hurry, the company can provide 3-day turnaround for your design.

The company requires that you provide a parts list; a mechanical drawing of the board's layout, including holes, pads, and connectors; instructions regarding special orien-



**A solderless breadboard with power supplies, logic switches, and removable circuit boards (3M)**

the use of chemicals and darkroom conditions, so you may want to consider having a local photoplotting facility create your drawings rather than actually investing in a photoplotter for your company. But only by the careful inspection of the hard copy a photoplotter derives from your Gerber data can you be sure that your CAD output conveys the



tation, grouping, and spacing for your components; special grounding requirements; a general physical description of the board; a list of specific board markings; and details about vias and etchings. In other words, this company will be your electronic draftsman, but you still must dictate the engineered aspects of the board.

On the other hand, if your company plans to design 30 or more boards a year, you may want to supplement your in-house CAD system with an in-house CAP (computer-aided prototyping) system. Devices that fall within this classification can take data generated by your CAD system and produce working prototypes within hours instead of days or weeks.

A company called ProtoCAD offers three CAP systems, all of which are turnkey systems that cost from \$40,700 to \$75,385, and come with installation, chemicals, and training. ProtoCAD's units use a system called optical direct imaging to write your circuit pattern into a layer of dry-film photoresist. This system doesn't involve the use of phototools, so it's relatively inexpensive to use. All of the company's CAP systems accept CAD data, drill the board, insert plated through-holes in the board, laminate dry-film photoresist onto both sides, directly write the circuit pattern into the photoresist with intense UV radiation, develop the photoresist, etch and strip the board, and then tin-plate it. The boards produced with these units are production-quality pieces. In addition, each system is self-contained, and ProtoCAD asserts that any waste materials are of such insignificant levels that they don't come close to violating even the most stringent environmental standard.

If your company plans to produce between 30 and 50 different boards a year, consider ProtoCAD's entry-

level system, which performs each of the aforementioned steps in sequence, one board at a time. At the high end, the company's \$75,385 system has both a numerical control (NC) drilling station and a photoplotting unit, so you can produce as many as 100 boards a week at a rate of five every four hours. Significantly, you don't have to come



**A behavioral data-management system that lets you interactively create signal definitions, device timing, data patterns, and waveform displays (Test Systems Strategies Inc)**

up with 100 new designs a week—these figures can be thought of as low-volume production runs. Costs for producing an 8×10-in. board can run as low as \$22, but on the average you can expect to pay about \$120 per board.

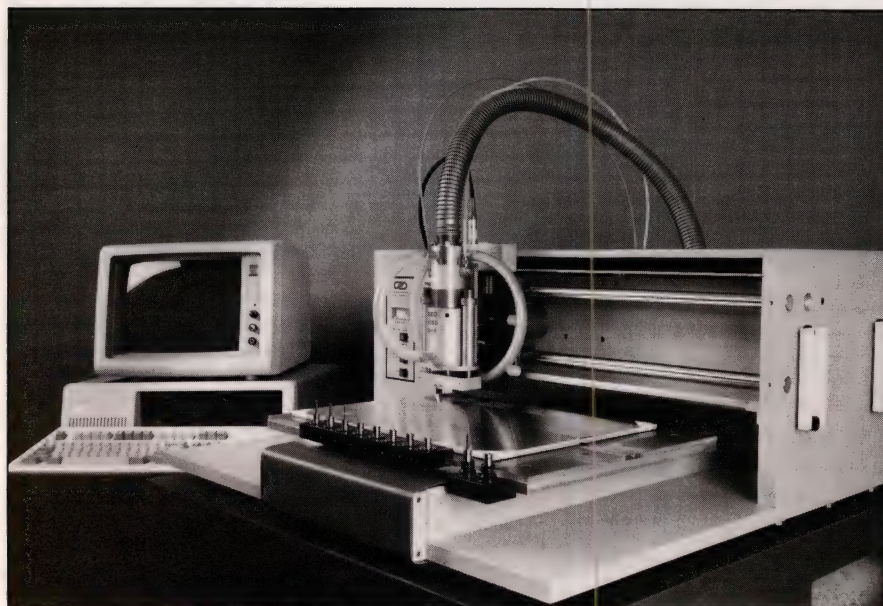
Having your own in-house facility for cranking out prototypes may seem like Nirvana, but there are important considerations besides the cost factor. Optical direct imaging is a wet chemical process in which board cleanliness is critical. The operator must be technically trained in a wide variety of process and control procedures. And if your equipment includes photoplotting capabilities, you'll have to deal with photographic processing and possibly provide a darkroom.



**The key to successfully working with an off-site board manufacturer lies in the sophistication of your CAE program and the quality of its output.**

Taking a different approach to CAP, Ozo Diversified Automation has two benchtop machines that perform circuit-board milling to mechanically engrave the copper away in order to define your board's traces. Accordingly, this process does not involve any wet chemical processing—you simply sweep up any debris. However, these machines are limited in that they lack the ability to provide through-hole plating.

Ozo's Model 18 can mill boards as large as 12×18 in. It costs \$27,996 for a workstation that includes a microscope head, a pen-plotter head, and an IBM PC-compatible computer for NC drilling and routing. You also get software that uses image-processing techniques to convert your Gerber data into outline form. On the aver-



**A computer-controlled circuit-board milling workstation (Ozo Diversified Automation)**

age, a 6×6-in. pc-board takes two to three hours to mill. Additional heads cost \$4000 to \$12,000. A Model 18 with a mechanical etch head costs about \$40,000, and for \$36,000 you can purchase a basic Model 24 that can mill boards as large as 18×24 in.

Besides lacking plated through-holes, prototypes generated by me-

chanical milling may differ from pc boards in high-frequency performance and trace-to-trace impedance. Also, copper debris melted into the epoxy at the base of a milled trough could cause shorts that are difficult to find and repair. The quality of your circuit's traces will depend significantly on the condition of the milling bit. But if you require instant gratification, CAP may be the only way to prototype.

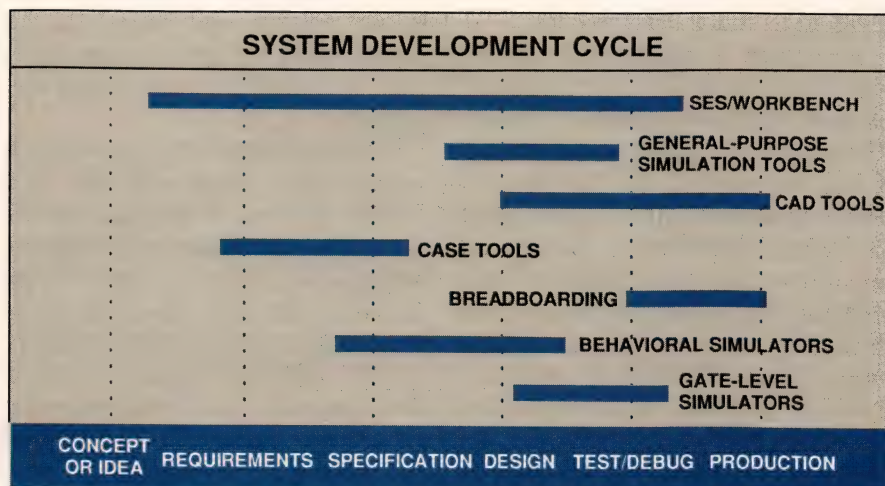
### **Debug it in software**

Then again, when you need to check-out the viability of an extremely complex, multilayer system, conventional CAD and prototyping systems may fall short of meeting your needs. In such a case, you may want to consider one of the many circuit-emulation programs that provide you with a single tool for designing, simulating, and debugging your circuit without reducing the schematic to hardware.

Test Systems Strategies Inc (TSSI) has a new product called WaveMaker, which creates and manages behavioral and functional data for electronic circuits. WaveMaker is a graphical interface for TSSI's TDS software package. It creates, captures, and uses state, timing, and data structure information from such sources as CAE design simulation tools, existing test programs, and test vectors generated by ATE systems in order to automate the link between CAE and ATE systems.

The \$20,000 WaveMaker package lets you view and edit signal definitions, waveforms, data patterns, and device timing. Using a mouse, you can generate stimuli and expected responses for your circuit during the initial design phase. You can then view the resulting waveforms just as if you had connected a logic analyzer to a physical circuit. A graphics editor displays viola-





**Fig 1—When comparing the strengths offered** by a variety of development tools, you can see that SES/workbench lets you computerize the conceptualization, specification, design, and verification of your system.

tions of expected response state values. Its interactive operation lets you alter device timing and then compare the simulation results. So, not only can you verify circuit functionality at the design stage, but you can even tune the circuit's performance.

Another product lets you look inside the registers of more than 4000 ICs, including  $\mu$ Ps, PLDs, and memory devices, without actually reducing your design to hardware. Acting like a software version of an

in-circuit emulator, SmartModel Windows from Logic Automation lets you single-step your circuit's performance in software, set breakpoints on internal register states, or set register values. This \$4000 product is actually an option in the manufacturer's \$7900 annual subscription service for the SmartModel library of devices. SmartModel Windows can only be used with Mentor Graphic's QuickSim simulator, but a version for Hewlett-Packard's Electronic Design

## Words of wisdom from board manufacturers

As manufacturers of pc boards, Rick Castonguay of Casco Electronics in Chatsworth, CA, ((818) 882-0972) and Emil Dragovich of Xcell Circuit in Anaheim, CA, ((714) 779-1300) have seen their share of design disasters generated by engineers who were inexperienced in CAE-based design. You might want to keep their tips in mind as you design your board for prototyping.

1. Send the prototype manufacturer both a Gerber tape and the artwork. A hard copy of your design will help prevent miscommunication and errors.
2. Fax written instructions for any changes. Good communication is paramount in the production of a prototype; you should avoid verbal instructions be-

cause they could be misinterpreted.

3. Photoplot your design. Although your design may look good on paper, you can only be sure of its integrity by proofing a photoplot.
4. Make the traces as large as possible in order to avoid oversights.
5. Use round pads—they're easier to register than other shapes.
6. Spend some time getting to know your system. Lack of experience is at the root of most design disasters.



**Only by carefully inspecting the hard copy a photo-plotter derived from your Gerber data can you be sure that your CAD output conveys the design you thought you created.**

System is under development.

Providing a dramatically different way of approaching the design process for those complex projects that seem to rebuff conventional CAE approaches, SES/workbench from Scientific and Engineering Software combines an icon-based graphical interface with object-oriented modeling and simulation tools for multilevel design evaluation (Fig 1). This \$28,000 software package provides a top-down approach to system design by permitting you to identify your circuit's high-level characteristics and specify its overall behavior and structure.

Once you've determined the general functions you want your circuit to perform, you can expand the circuit specifications at progressively lower levels of detail until you finally reach the component level. In other words, instead of starting out by defining your overall objective on a pad of paper and entering the computerized phase of your design only after you've determined which components will accomplish that objective, SES/workbench lets you automate every step of the design process all the way through the test and debugging stage. This program

is particularly well suited to the simulation of highly concurrent systems that exhibit extensive parallel activity.

Unfortunately, the ease with which SES/workbench lets you model a complex system may be offset by the subsequent task of translating your icons into operational hardware. Because the program is written in an object-oriented super-set of C and C++, you can extend the program's standard modeling primitives, write calls to external routines, or access any of the program's data structures. But take heart: At the University of Texas, at least one graduate thesis has been presented that defines a way of interfacing SES/workbench with a schematic design program. **EDN**

**Article Interest Quotient  
(Circle One)**

**High 518 Medium 519 Low 520**

## For more information . . .

For more information on breadboard and prototyping products such as those discussed in this article, circle the appropriate numbers on the Information Retrieval Service card or use EDN's Express Request service. When you contact any of the following manufacturers directly, please let them know you saw their products in EDN.

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Circle No 425

**National Design Inc**  
9171 Capital of Texas Hwy  
Houston Building  
Suite 230  
Austin, TX 78759  
(512) 343-5055  
FAX 512-343-5053  
Circle No 426

**Ozo Diversified Automation Inc**  
7450 E Jewell Ave  
Suite A  
Denver, CO 80231  
(303) 368-0401  
FAX 303-368-4865  
Circle No 427

**ProtoCAD Inc**  
1050 Elkton Dr  
Colorado Springs, CO 80907  
(719) 548-0222  
FAX 719-599-9221  
Circle No 428

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Engineering Software Inc**  
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FAX 512-479-6217  
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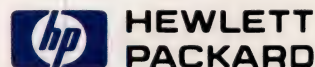
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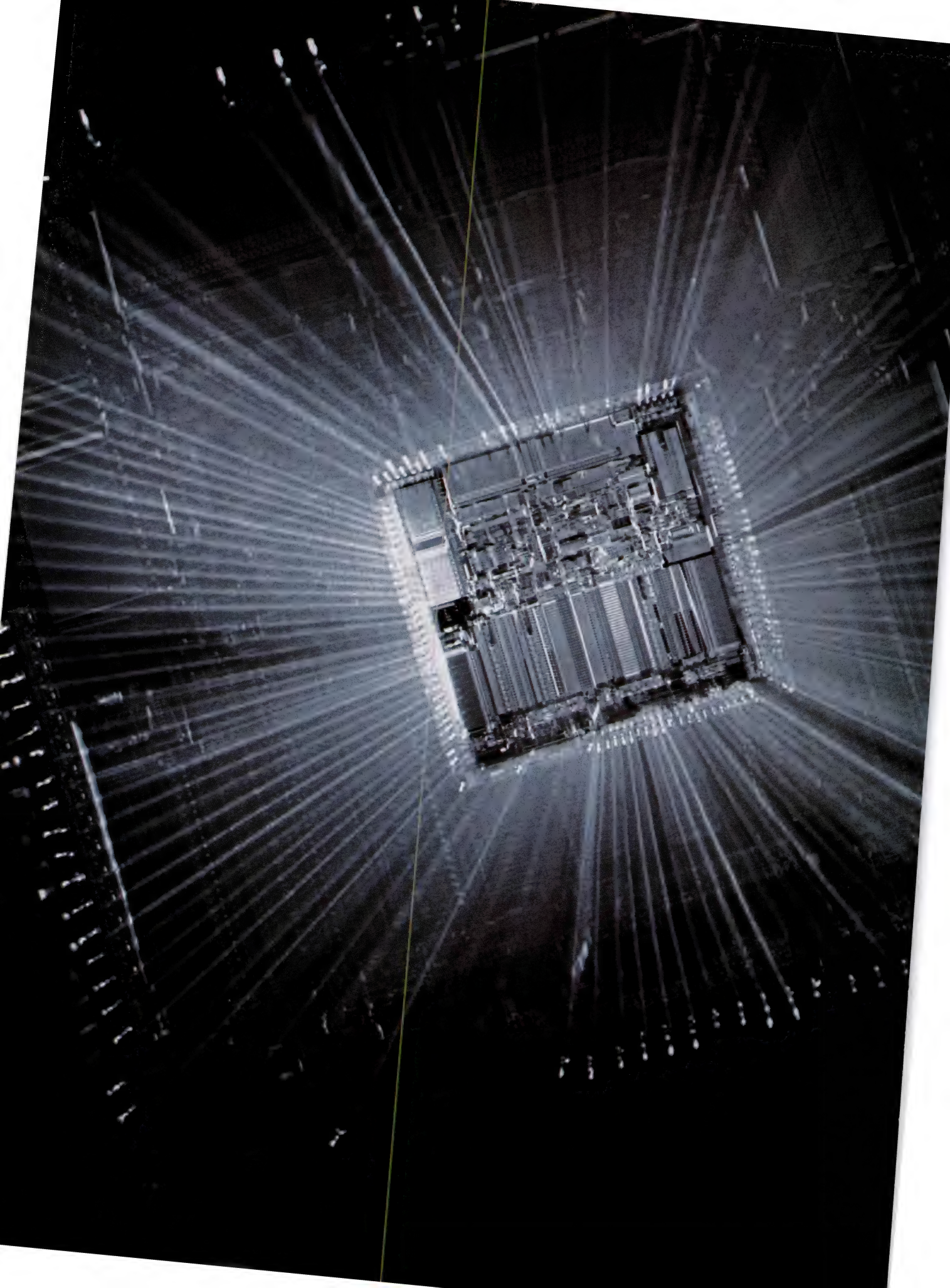
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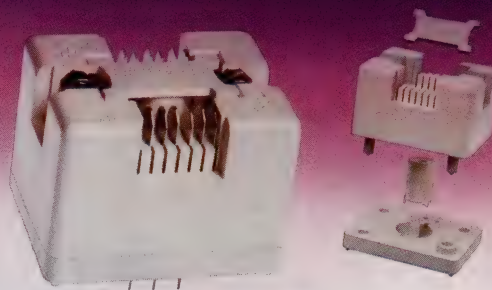
Our Xydar<sup>®</sup> resin, for example, has excellent dimensional and creep stability at elevated temperatures. It is a natural choice for higher density connectors and IC sockets. Plus, it has low ionic contamination and is ideal for surface mount assembly.

For more information, write for our brochure, "Engineering Plastics for Performance and Value." Amoco Performance Products, 38 C Grove Street, Ridgefield, CT 06877. Or call 1-800-621-4557.



**Amoco Performance Products**  
The higher performance plastics.

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CRITICAL THAN  
YOUR ABILITY TO  
RELY ON OUR  
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Xydar<sup>®</sup> resin was chosen by J.M. Ney for this extremely high temperature burn-in socket because of its dimensional and creep stability at temperatures above 200°C.



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VACUUM FLUORESCENT  
DISPLAYS ☐ MODULES

Patented and manufactured by  
ISE ELECTRONICS CORP.



Model CU205SCP-B

## DOT CHARACTER DISPLAY MODULES

CHARACTER FORMAT	MODEL NUMBER	NUMBER OF CHARACTERS	CHARACTER HEIGHT (MM)	INPUT (SERIAL/ PARALLEL)	BI-DIRECT BUS
5 x 7 DOT MATRIX	CU165SCP-B-S	1 x 16	5.0	S/P	
	CU169SCP-B-L	1 x 16	9.0	P	X
	CU205SCP-B-S	1 x 20	5.0	S/P	
	CU209SCP-B-L	1 x 20	9.2	P	X
	CU2015SCP-B-L	1 x 20	15.1	P	X
5 x 7 DOT MATRIX PLUS CURSOR	CU406SCP-B-S	1 x 40	5.0	P	X
	CU20026SCP-B-S	2 x 20	5.1	P	X
	CU40026SCP-B-S	2 x 40	5.0	P	X
	CU40046SCP-B-S	4 x 40	5.0	S/P	X
	CU40066SCP-B-S	6 x 40	5.0	S/P	X
	CU40086SCP-B-S	8 x 40	5.0	P	X

The models shown are typical examples of the broad selection available for immediate delivery. Contact our nearest Sales Office or Representative to help select the right Noritake VFD for your application as well as for details on costs, custom designs, etc.

## DOT MATRIX DISPLAY MODULES

DOT MATRIX FORMAT (DOTS/LINE x NO. OF LINES)	MODEL NUMBER	NO. OF LINES AND CHARACTERS/LINE (5 x 7 DOT CONFIGURATION)	GRAPHICS CAPABILITY
192 x 16 (3072 DOTS TOTAL)	GU192X16	2 x 32	YES
256 x 16 (4096 DOTS TOTAL)	GU256X16	2 x 42	YES
256 x 64 (16,384 DOTS TOTAL)	GU256X64	8 x 42	YES

Model GU192X16



## NORITAKE SALES OFFICES

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Phone: 06142-43095/96/97 ☐ FAX: 06142-22799 ☐ TLX: 4182982dnd

NORITAKE CO., LTD. ☐ Electronics Division

JAPAN: 1-36 Noritake Shinmachi, 3 Chome, Nishi-Ku, Nagoya  
Phone: (052) 562-0336 ☐ FAX: (052) 581-1679 (GIII) ☐ TLX: 59738

## REPRESENTATIVES

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So. CA: SD (619) 292-1771 / OC (714) 891-4621 ☐ ELSCO

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CO, UT: (303) 794-4684 ☐ MRC

OH, WV, W. PA, KY: (216) 461-6161 ☐ Arthur H. Baier

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N.E.: (508) 788-0316 ☐ International Mktg. Group

PA, MD, DE: (215) 233-0333 ☐ C.H. Newson & Associates

FL, PUERTO RICO: (407) 831-8233 ☐ Semtronic Asso., Inc.

NY, NJ: (201) 376-3324 ☐ F.F. Sylvester Associates

VA: (804) 740-0063 ☐ Glasscock Associates

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Our SVE-Series tantalums incorporate a fuse to minimize damage from reverse current. Compatible with our R-Series,

the SVE capacitors are ideal for noise absorption in computers, terminals or measuring equipment. Choose from 21 types with ratings from 1.0 to 33  $\mu$ F and from 10 to 50V DC.

**10  $\mu$ F power in  
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R-Series extended-capacitance chips offer ratings up to 10  $\mu$ F in the A case measuring 1.6 x 3.2 x 1.6 mm. The extended R-Series consists of 46 device types with

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NEC not only produces more tantalum caps than anyone in the industry, we also invest more of our resources in intensive R&D programs dedicated to giving you the best device for your design. To find out how our tantalums give you maximum performance per micron, call NEC today. Ask about the SVE-Series with the built-in fuse or R-Series extended-capacitance chips.

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# Hardware and Interconnect Devices

## U-shaped section forms base and sides of aluminum case

The Type 33 aluminum case has a U-shaped section forming its base and sides, both of which have slots for direct card mounting. The case also has an extruded cover, which fastens to the base with the same screws that mount the front and rear panels. Press-fitted bezels conceal all the screws. The aluminum design provides interference attenuation. The case is available with or without ventilation slots in the base and front and rear panels. In addition, aluminum panels are available with a sealing rim of foamed material that conforms to the IP54/NEMA 4 protection class.

An accessory handle fastens in



the side groove without drilling and permits the case to be tilted at an angle. Other accessories include card-carrier fittings for 100×160-mm Eurocards with DIN 41612 connectors, double Eurocard mounting sets, and receptacles for 3½- and 5¼-in. disk drives. The 2-tone gray case comes in heights of 2.72, 3.37, and 4.06 in.; widths of 6.12, 8.27, and 10.1 in.; and depths of 5.67, 8.03, 10.39, and 12.76 in. Prices start at \$35.

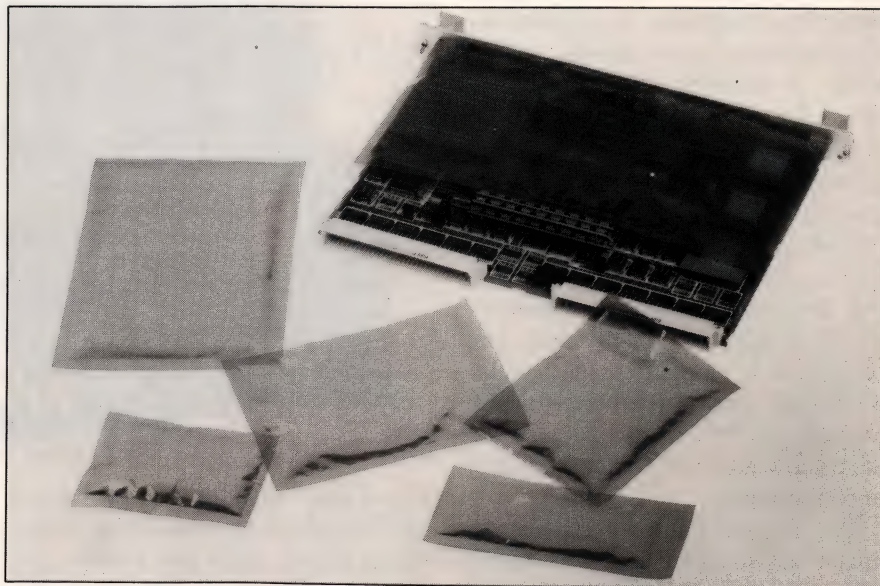
**ELMA Electronic Inc, 41440 Christy St, Fremont, CA 94538. Phone (415) 656-3400. FAX 415-656-3783.**

Circle No 463

## Liquid heat sink available in six standard sizes

The Fluorinert liquid heat sink (LHS) is a multilayer plastic package containing Fluorinert liquid. It dissipates heat in tight spaces by the natural convection of the liquid. The LHS comes in six standard sizes: 1.5×4, 2×3, 3×4, 3×4.75, 4×6, and 4×9 in. All sizes are 0.25 in. thick. The LHS transfers heat from an active component to the opposite LHS wall for conduction to an exterior surface. Its operation is completely passive, thereby eliminating the noise and dust-contamination problems associated with fans.

The units can be used with power densities as high as 15W per in.<sup>2</sup> and have a dielectric strength that exceeds 35 kV across a 0.1-in. gap. The liquids are perfluorocarbons, which do not contain hydrogen, chlorine, or bromine. Because these liquids are not chlorofluorocarbons,



they will not damage the ozone layer. A 3×4.75-in. sample is available by request on company letterhead. Prices range from \$10.40 to \$19.20, depending on size.

**3M Co, Dept CH89-06, Box 33600, St Paul, MN 55133. Phone (612) 733-5755. FAX 612-736-3094.**

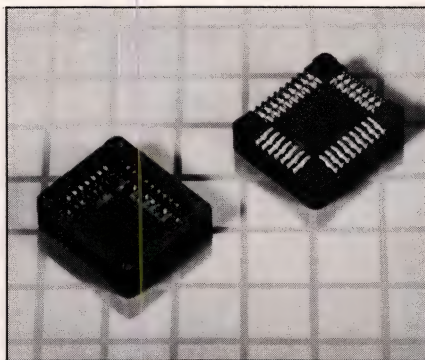
Circle No 464



# Hardware and Interconnect Devices

## Surface-mount PLCC chip sockets measure 0.2 in. in height

These surface-mount PLCC chip sockets have visible internal solder tails. Their configuration combines the handling and small-size advantages of the J-lead package with the inspection and repair advantages of the gull-wing package. The sockets measure 0.2 in. in height when mated with a surface-mount chip. The sockets use the same board pattern as a standard JEDEC chip and have a high-pressure contact system, which eliminates the need for gold plating. The units have a center pad for structural integrity and adhesive bonding.



The sockets' electrical specifications include a contact resistance of 15 m $\Omega$  max after testing, an insulation resistance greater than  $1 \times 10^4$

M $\Omega$ , capacitance of less than 1 pF at 1 kHz, self inductance of less than 5 nH at 500 kHz, and mutual inductance of less than 1 nH at 500 kHz. The sockets meet MIL-STD-810C standards for shock, vibration, and acceleration. Prices range from \$0.035 to \$0.05 per contact depending on quantity.

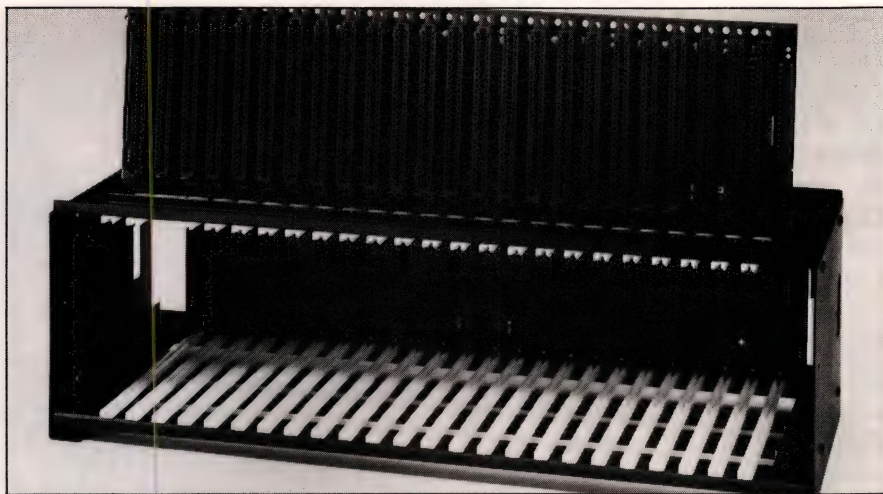
**Methode Electronics Inc., Interconnect Products Div., 1700 Hicks Rd., Rolling Meadows, IL 60008. Phone (800) 323-6864; in IL, (312) 392-3500. FAX 312-392-9404. TWX 910-687-0760.**

Circle No 465

## STD Bus backplane supports synchronous clock speeds of 16 MHz

The BLaCKPLane is an STD Bus backplane capable of supporting synchronous clock speeds of 16 MHz. It achieves this high speed through a multilayered design that separates the signal, power, and ground planes. The signal layer has ac-coupled termination networks placed at both ends of the signal line to minimize overshoot and ringing. Because the networks present no dc loads to bus drivers, the backplane is compatible with older STD Bus cards with limited drive capability. The backplane also accommodates Fast, AC, and Act logic families.

The BLaCKPLane's design maximizes the distance between signal traces, thus limiting the crosstalk between adjacent traces to less than 0.09%. Separating the power and ground planes from the signal traces permits a design that minimizes the power- and ground-plane



impedance without compromising the characteristic impedance of the signal traces. Multiple power- and ground-connection points along the length of the backplane and a capacitor at each power-entry point for each slot ensure low power and ground impedances. Voltage stabilizers and low, ESR-rated capaci-

tors permit the backplane to handle 36A at 5V, 6A at  $\pm 12V$ , and as much as 50A of ground current. Prices start at \$144.

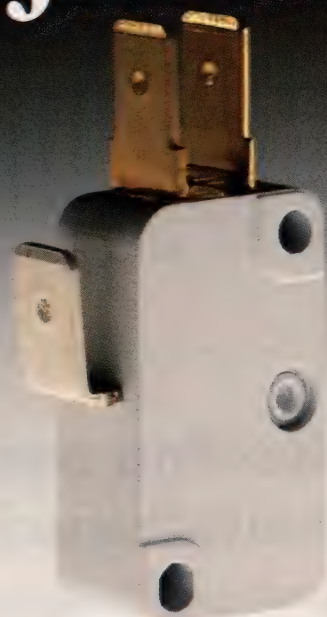
**Matrix Corp., 1203 New Hope Rd., Raleigh, NC 27610. Phone (919) 833-2000. FAX 919-833-2550.**

Circle No 466





# Juice!



When the world needs "juice" in a hurry—and especially when the world needs it again and again, quickly and reliably—the world turns to a powerful quick-connect solution.

The AMP Ultra-Fast line of preinsulated, machine-feed FASTON receptacles and tabs.

And the world knows a good thing. To make our Ultra-Fast line, we take premier, stress-relieved FASTON connectors and insulate with nylon 6/6 to shrug off the stress of crimping and provide UL temp ratings of 105°C. We do it with a wide, wide range of styles and color-coded sizes.

And, so the line lives up to its name, we back it with industry's best-known application tooling, from hand tools to automatic harness-making machines.

For any production rate you need. And a crimp so consistent it's certifiable.

We offer advances, too, like our Ultra-Fast Plus line. Two types of plastics are co-molded to form the housing. The front half insulates. While the back half crimps to the wire insulation for extra strain relief. Plenty enough to meet VDE insulation support requirements.

The Ultra-Fast line covers 26-10AWG, with large-insulation-diameter versions for 22-10AWG (great for 2-wire applications). If you need juice—fast, simple, and reliable—there's one there for you, with just what you need: All the performance and productivity you expect from AMP.

**Call 1-800-522-6752 for details on the Ultra-Fast line. AMP Incorporated, Harrisburg, PA 17105.**

## **AMP** Interconnecting ideas

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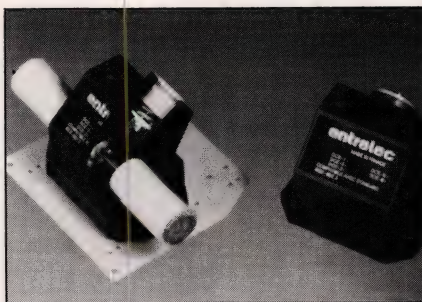


# Hardware and Interconnect Devices

## Coaxial-cable tap connectors install without service interruption

These coaxial-cable tap connectors tap into Ethernet-network coaxial cable. Their design permits a reliable connection between a transceiver and the network cable without cutting or displacing that cable. The connectors meet all of the requirements of the IEEE-802.3 standard. The units can be switched on and off by removing the contact pin; you can test the signal through the contact-pin opening.

The connectors are available with BNC or TNC plugs, or they can be mounted onto a printed-circuit board with solder or plugs. You can install the units on-line without



service interruption. Mounting directions and a cable-perforation tool come with the units. Their electrical specifications include a contact resistance of less than 10 m $\Omega$ , an insulation resistance greater than 5000 M $\Omega$  at 500V, and a capacitance of

less than 2.5 pF. In addition, the units can withstand 1500V at 50 Hz between the center conductor and the shield. The connectors operate from -50 to +60°C, and the insulation material conforms to the UL 94V-O recommendation. Model DCE-1, which solders directly onto a pc board, lists for \$24.86. Delivery is 4 to 6 weeks ARO.

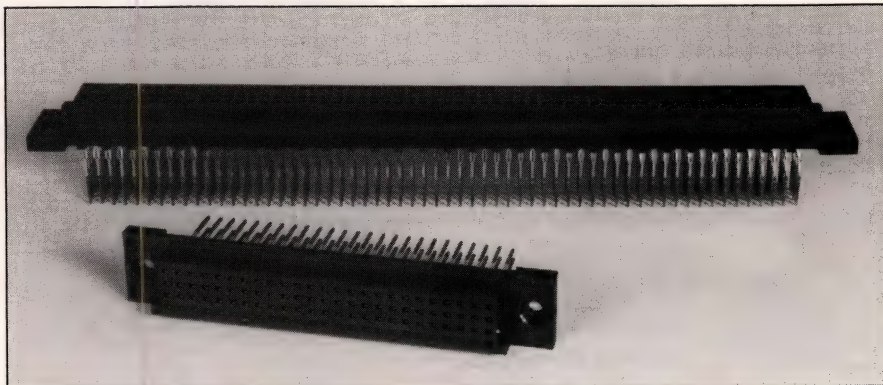
**Entrelec, 2 Ram Ridge Rd, Spring Valley, NY 10977. Phone (800) 431-2308; in NY, (914) 425-7460. FAX 914-425-8108**

Circle No 467

## Female connector has four rows with 0.1 $\times$ 0.1-in. contact spacing

The HDC Series consists of female socket connectors with 4 rows of 0.1  $\times$  0.1-in. contact spacing and are available with 100 to 240 pins. The terminals feature a 0.25- or 0.55-in. press-fit Flexpress contact that requires no soldering. Electrical specifications include a maximum contact resistance of 20 m $\Omega$ , an insulation resistance greater than 10<sup>12</sup> $\Omega$ , a current rating of 1A at 100°C ambient and 4A at 20°C ambient, and a dielectric voltage of 900V rms.

The connectors require an insertion force of 4 oz per contact max and a withdrawal force of 0.75 oz per contact min. The contacts have either gold or Robex-plated coat-



ings. You can repair the connector by replacing the individual contacts. Contact installation requires a simple flat insertion tool that pushes into the insulator. The connectors cost \$0.20 per pin (100).

**Robinson Nugent Inc, Box 1208, New Albany, IN 47150. Phone (812) 945-0211. FAX 812-945-0804. TLX 810-540-4082.**

Circle No 468



# Global Interface

**From standard connectors to custom overmolded cable assemblies, Molex makes the connection.**

Molex offers you a broad line of reliable, innovative I/O connectors with full shielding where higher speed signal transmission is required.

Molex has developed a series of high density D-subminiature and circular mini din connectors satisfying the need for increased performance functions and miniaturization.

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As part of our systems design approach, we offer a full range of application tooling from hand tools to automated assembly machines. Or we can provide pre-tested custom overmolded cable assemblies that match both appearance and performance specifications of your equipment.

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Molex's distribution network ensures local inventory availability.

Recognizing your needs as an international marketer, Molex's multi-national coordination of sales, design and manufacturing services works to meet your global interconnection needs.

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*Durable SEMCONN<sup>™</sup> shielded plug and receptacle available in 4, 6, 8 and 16 circuits. Positive locking plugs and easy in easy out applications.*

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CIRCLE NO 97



**YOU CAN SEE HOW  
CLEAR AND BRIGHT THE PICTURE IS.**

**WHAT YOU CAN'T SEE IS  
HOW FAST IT RESPONDS.**

**F**ast response time, less than 5 ms, gives Finlux Electroluminescent displays video capability. In laptop PCs, the cursor is visible during all rapid movements or data changes.

As for picture quality, you can see for yourself: it's worth a thousand words. Here are just a few: Crisp. Stable. Bright. Wide-angle viewing. Finlux EL is easy on the eyes, even during a long workday.

### **The big little EL display**

The display above is shown as large as life. Just 18 mm thin and weighing less than 500 grammes, this Finlux EL shows as much text as an 11" CRT: 25 lines of 80 characters, or full graphics. Finlux EL displays are available in a range of 320x256 to 640x400 pixels.

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Finlux EL displays are easily interfaced for high-resolution graphics, word processing, medical and industrial applications. The fully solid-state flat EL panel and electronics are assembled into a sturdy, compact package ready for mounting in even the most demanding environments.

Lohja Finlux is the only European manufacturer of flat panel Electroluminescent displays.

To see more, get in touch with:



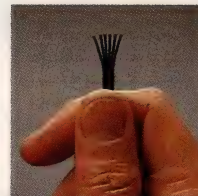
**FINLUX**

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Telephone (+358-0) 420 01  
Telecopy (+358-0) 422 143  
Telex 125023 ldis sf

In the USA:  
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20395 Pacifica Drive  
Suite 109  
Cupertino, CA 95014, USA  
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**CIRCLE NO 99**





# MULTIFILAR<sup>®</sup>

## MAGNET WIRE

**Parallel bonded for windings and leads.**

When two or more magnet wires travel together, MULTIFILAR magnet wire is an excellent alternative.

This parallel bonded, color-coded magnet wire offers more consistent capacitance and impedance characteristics when compared to windings using two or more separate magnet wires.

And, it allows for increased layer winding speeds, as well as reduced labor and handling. Color-coding assists in conductor identification and helps eliminate termination errors.

MULTIFILAR magnet wire is custom produced to guarantee flat, parallel construction in an array of sizes, 16–52 AWG, with up to 20 conductors in some sizes.

Available constructions include round, flat or square conductors. Individual conductors meet NEMA MW 1000, JW 1177, temperature classes 105–220°C; single through quadruple film builds. Color-coded conductors are available in most insulations with up to 10 different colors in some sizes.

Call or write for your free copy of our Technical Data Booklet and Capabilities Brochure. Both contain valuable information on all wire produced and inventoried by MWS Wire Industries. Samples of MULTIFILAR are available upon request.



# MWS

## Wire Industries

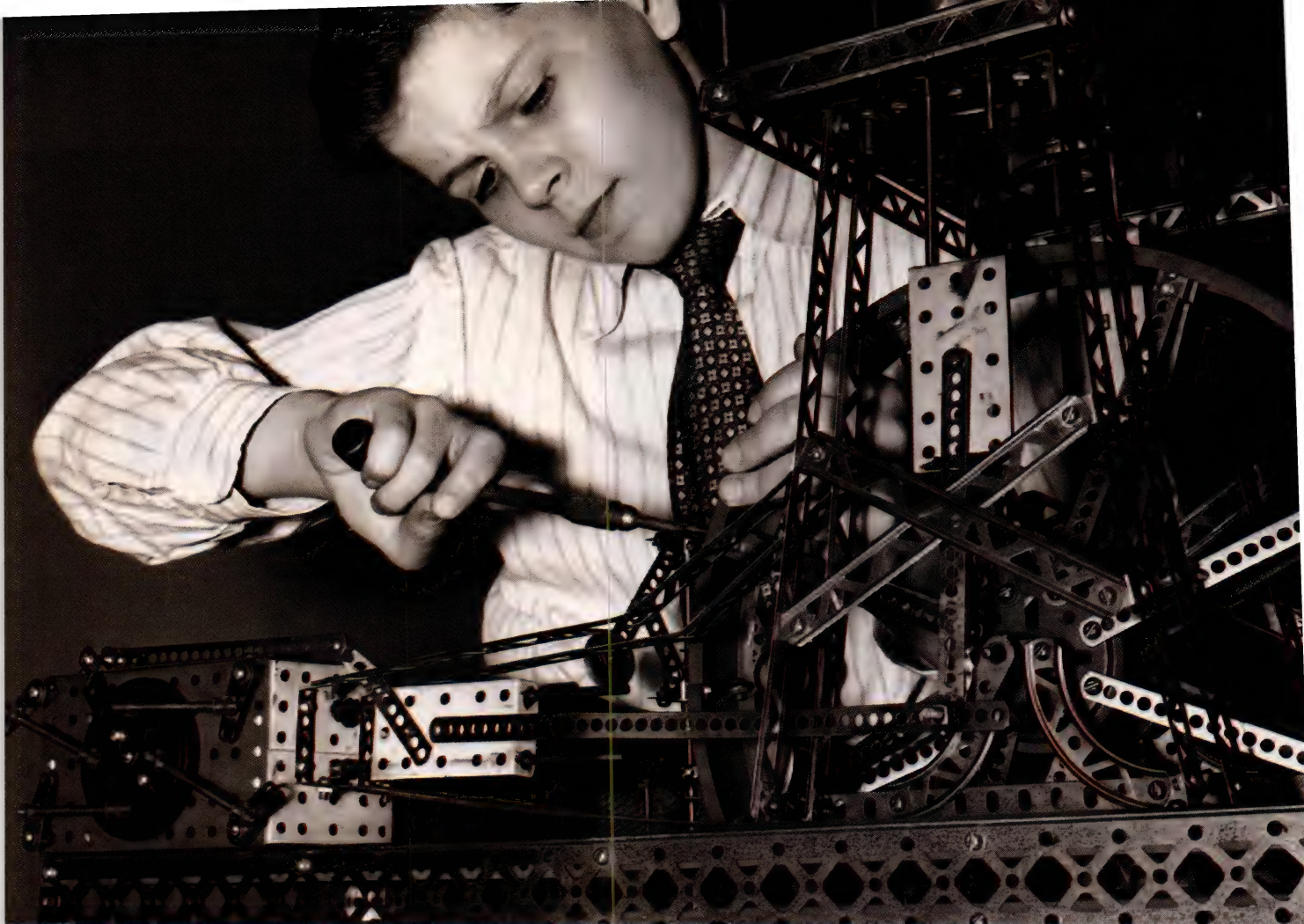
31200 Cedar Valley Drive, Westlake Village, CA 91362

**CALL TOLL FREE 800 423-5097**

In California 800 992-8553. In L.A., 818 991-8553

MULTIFILAR<sup>®</sup> is a registered trademark of MWS Wire Industries  
CIRCLE NO 104





The Bettman Archive Inc.

# Even the most ambitious project is limited by its parts.

Most kids use the pieces of their building toys just like they came out of the box. So they're limited by the characteristics of those pieces.

The same is true of today's suppliers of "custom" interconnect systems. Assembling systems from components that are readily available, they call these products custom when they're really only customized.

At Precision Interconnect we're often not satisfied with

the components or assembly procedures readily available. So we design, test and implement our own.

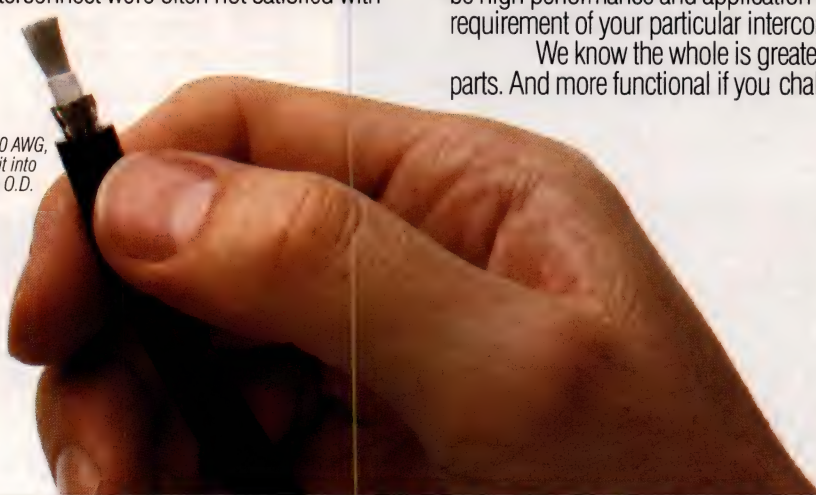
First we ask every question imaginable about the application of the product. Then we apply our knowledge of manufacturing, materials, cable and connector designs, and termination processes to solve the problem.

So the complete interconnect systems we deliver will be high performance and application specific, meeting every requirement of your particular interconnect problem.

We know the whole is greater than the sum of the parts. And more functional if you challenge those parts.

*P.I. miniaturized this cable of 68/40 AWG, 50 ohm coaxes to a .192" O.D. to fit into the end of an endoscope tube. The O.D. of one RG-59 is .242".*

CIRCLE NO 103



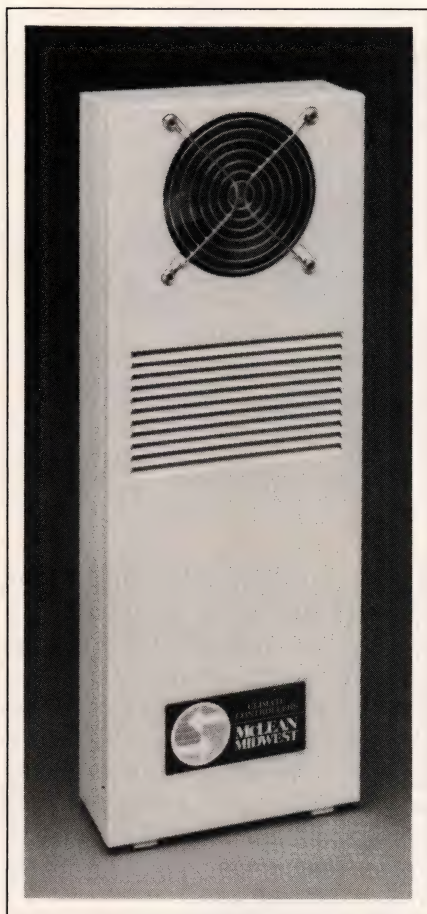
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Portland, OR 97224  
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Wilmington and Düsseldorf.



# Hardware and Interconnect Devices



## HEAT EXCHANGERS

The Proair series heat exchangers consist of six heat exchangers that have cleanable exchanger cores and contain no filters. The XR-20, the smallest model, measures  $20 \times 7\frac{1}{2} \times 3$  in. It can remove 400W of heat from a sealed enclosure and maintain an average temperature of approximately  $28^{\circ}\text{F}$  above the ambient temperature in the enclosure. This unit operates at temperatures as high as  $155^{\circ}\text{F}$  and is available for 115 or 230V ac outlets operating from 50 to 60 Hz. Other units conform to international cabinet lengths of 29, 47, and 60 in. Two draw latches on the bottom of the exchangers access the slide-out, cleanable core. Each unit, approximately \$390.

**McLean Midwest, 4000 83rd Ave N, Brooklyn Park, MN 55443. Phone (612) 561-9400. TLX 290883. FAX 612-569-0533.**

Circle No 611

## PC-BOARD CONNECTORS

The BetaFlex family of 22 pc-board connectors comes with a centerline pitch ranging from 0.025 to 0.1 in. Configurations include 80 to 320 contacts with a 0.025-in. pitch; 50 to 300 contacts with a 0.04-in. pitch; 40 to 240 contacts with a 0.05-in. pitch, and 20 to 120 contacts with a 0.1-in. pitch. Because the units are stackable they can deliver densities as high as 80 contacts/in. A .025-in.-pitch connector with 320 contacts occupies a footprint of  $4.68 \times 0.5$  in. The total height of the connector is 0.42 in.

To install the connector on a pc board, you use a low-voltage power supply to open a shape-memory-alloy actuator. After the board is inserted, you remove the supply, and the actuator closes on the board. The mechanical construction is rated for a minimum of 500 cycles. Nickel-contact areas are plated with a minimum of 30  $\mu\text{in.}$  of gold. Demonstration kit including multidensity connector with 0.025-, 0.05-, 0.1- and 0.3-pitch centerlines; a mating pc board; and a power supply for the actuator, \$500; \$0.25 to \$0.35/contact (1000).

**Beta Phase Inc, 1060 Marsh Rd, Menlo Park, CA 94025. Phone (415) 494-8410. FAX 415-327-1163.**

Circle No 612

## COMPONENT MOUNTS

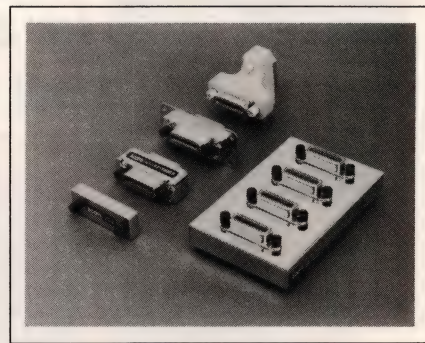
The Vert-O-Mounts series of vertical-component mounts permit you to install components, such as DO-7, DO-34, and DO-35 diodes and 0.125, 0.75, and 0.5W resistors in a vertical position on a pc board. They are available with positions for 1, 2, 3, and 4 components. The mounts not only save valuable pc-board space, but they also cushion the components against vibration and shock.

The mounts also have standoffs that facilitate cleaning. A total of 12 mounts are available in heights of 0.312, 0.437, and 0.562 in., which meet MIL-M-38527/11 and WS-

653E requirements. The molded units are made of a black thermoplastic polyester, which meets MIL-P-46161, grade B, class 30 specifications. The material meets the UL requirements for continuous operation at  $130^{\circ}\text{C}$ . \$37.50 (1,000,000 in 10,000,000 lots).

**Bivar Inc, 4 Thomas, Irvine, CA 92718. Phone (714) 951-8808. FAX 714-951-3974. TLX 852348.**

Circle No 613



## IEEE-488 PRODUCTS

These five interconnection devices contribute to a more effective means for interfacing with the IEEE-488 bus. The Model CIB24BA, a bulkhead connector, provides a simplified method for routing the multiple signals through a panel or enclosure. Model CIM24RA, a right-angle adapter, rotates a bulky cable  $90^{\circ}$ . Model CIB24X, an extender adapter, lengthens an IEEE-488 cable without stress. Model CIB24XR, a reverse-entry adapter, pivots a cable  $180^{\circ}$  and is available with male and female, or female and female connectors.

The multitap bus strip comes in two models, CIB24MT and CIB24MT2, and accommodates as many as eight IEEE-488 cables and connectors. You can disconnect any of the cables without disturbing the others. CIB24BA, \$24.50; CIM24RA, \$26.50; CIB24X, \$19.50; CIB24XR, \$21; CIB24MT, \$78.50; CIB24MT2, \$159.50.

**L-COM Data Products Inc, 1755 Osgood St, North Andover, MA.**



# Hardware and Interconnect Devices

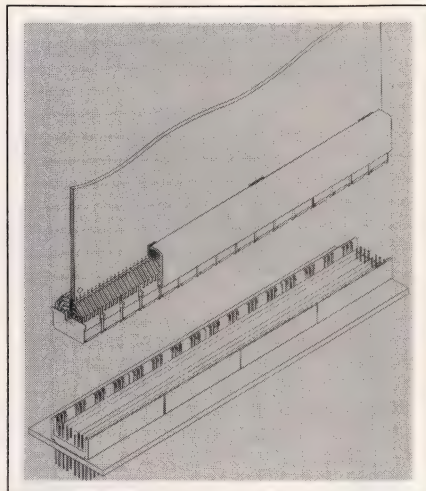
Phone (508) 682-6936. TLX 882157.  
FAX 508-689-9484.

Circle No 614

## CONNECTION SYSTEM

You can use the HD + 80 backplane connection system to mount daughter boards on mother boards. Based

on the company's 4-row HD + format, the system provides a density of 80 contacts/in., using eight rows of contacts—six rows of signal contacts and two rows of low-inductance contacts. This configuration eliminates the need to sacrifice signal pins for ground and power pins. Contact grid spacing is  $0.05 \times 0.1$



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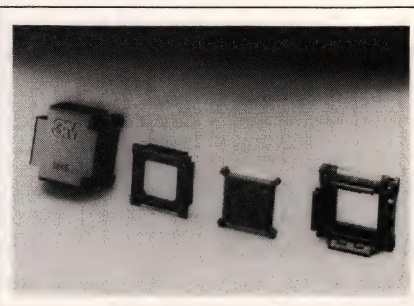
**Crenlo, Inc.**  
1600 - 4th Ave. N.W.  
Rochester, MN 55901  
Phone 507-289-3371  
FAX #507-287-3405

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in. on the daughter board and  $0.1 \times 0.1$  in. on the backplane. The backplane and daughter board have press-fit contacts, which let you terminate the contacts on both sides of the daughter board. The format permits connectors to be arranged end to end, thus permitting custom configurations. Depending on customer requirements, \$0.10 to \$0.30/mated contact pair.

**Teradyne Connection Systems Inc., 44 Simon St, Nashua, NH 03060. Phone (603) 889-5156, ext 509. TWX 710-228-1431.**

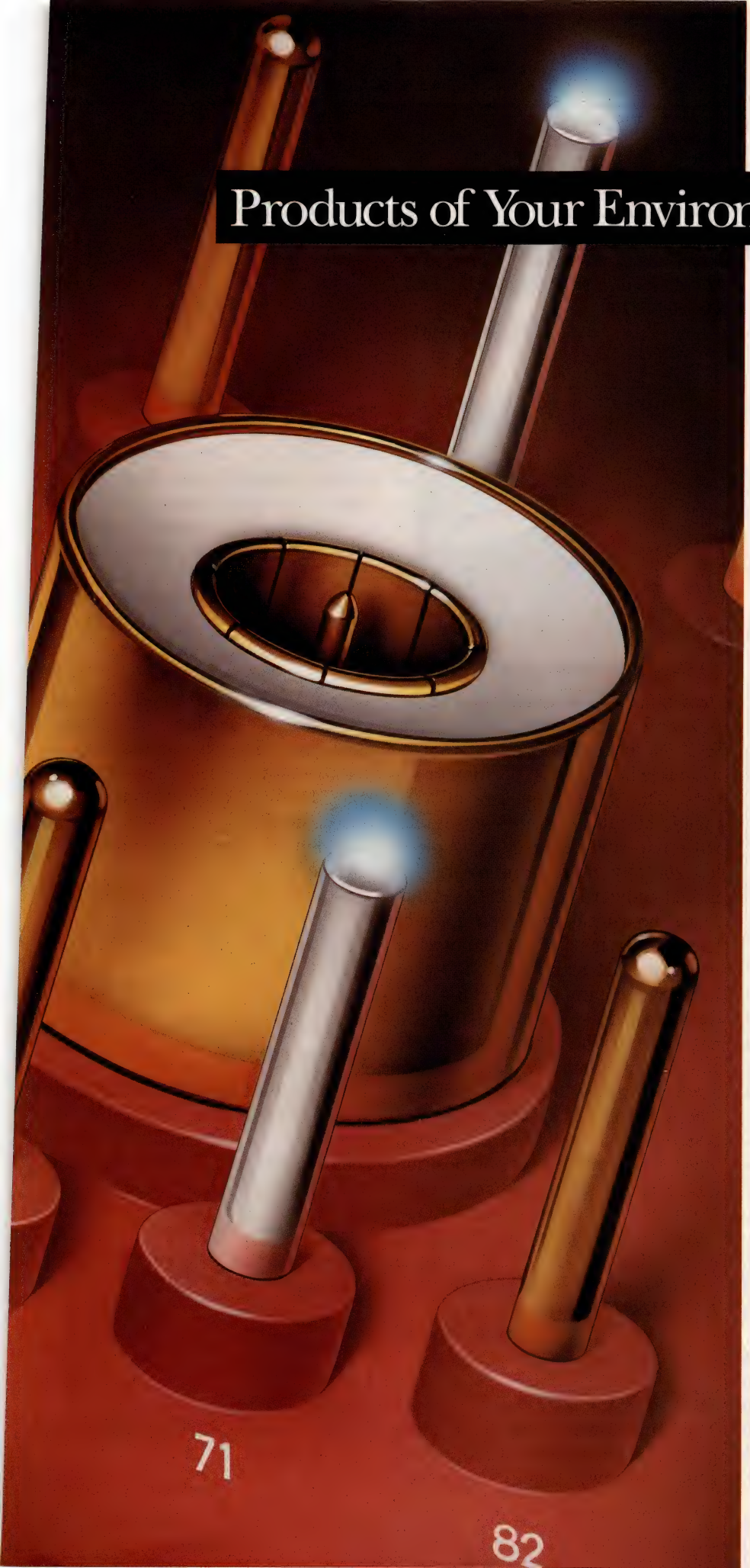
Circle No 615



## FLAT-PACK SOCKETS

These end-use sockets are designed for plastic quad-flat-pack devices. Socket contacts are on 0.025-in. centers. Units that accommodate flat packs with 84, 100, 132, and 164 leads are available. The design of the socket body and lid protects  $\mu$ Ps during handling, loading, and end use. You can apply the lids to





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*Worldwide Headquarters*  
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CIRCLE NO 105

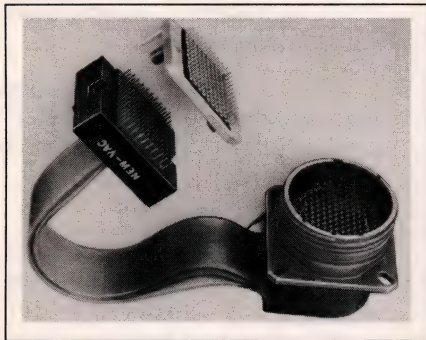


# Hardware and Interconnect Devices

the  $\mu$ Ps while they are still in IC handling trays. Tines in the lid grip gull-wing packages for pick-and-place or manual-handling operations. The body latches audibly snap into lid grooves to secure the lid/package assembly. A latching tool ensures manual alignment and insertion of the lid/flat-pack assembly into the socket. By applying downward pressure to the tool, you load the device and securely close the hinged socket latches around the lid. The sockets will operate over a range of  $-55$  to  $125^{\circ}\text{C}$ . 100-position socket, \$14.38 (100).

**3M, Electronic Products Div, Box 2963, Austin, TX 78769. Phone (512) 834-6563.**

Circle No 616



## EXTENDER/CONNECTOR

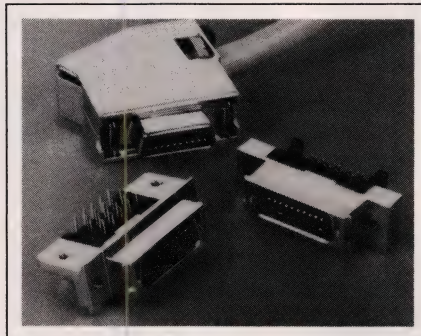
The Board Saver, an extender/connector combination for troubleshooting purposes, eliminates the need for disconnecting a soldered or hardwired-multipin connector on a mother board when a failure occurs. The extender consists of a glass-epoxy dielectric base that permanently attaches to the mother board. The extender has an array of low-profile, low-insertion-force pin receptacles for the connector to plug into. A polarization key and locking-jack screws provide error-free mating.

The connector detaches from the mother board after debug, and the extender remains affixed to the board. The extender arrays provide from 10 to 150 pin positions. The connector can attach to a wide vari-

ety of cable types and gauges. 60-pin model, \$30 (100). Delivery, four to six weeks ARO.

**New-Vac Electronics Inc, 9035 Eton Ave, Canoga Park, CA 91304. Phone (818) 998-4818. FAX 818-998-8710.**

Circle No 617



## CONNECTION SYSTEM

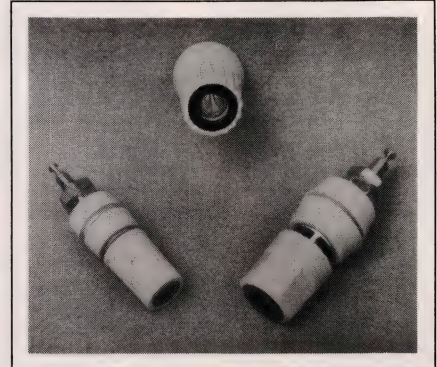
Providing a 50-mil pitch on the input and output connectors, the PAK-50 interconnection system is available in 20- to 100-position products. The system consists of a 2-piece, 50-mil flat-cable assembly with flat-cable connectors, 2-piece horizontally mated and vertically mated pc-board connectors, a right-angle board-mounted I/O connector, and a mating I/O connector with an EMI shield. The I/O connector accommodates #28 AWG discrete wire. When mating the connectors, the female and male contacts dynamically deflect, thus facilitating the high pin density. The interconnect system requires a 20g insertion force and provides a 100g min normal force. 50-position connector system, \$44/set. (100). Delivery, four to six weeks ARO.

**Robinson Nugent Inc, Box 1208, New Albany, IN 47150. Phone (812) 945-0211. TWX 810-540-4082. FAX 812-945-0804.**

Circle No 618

## BINDING POSTS

The Ring 5-way series of binding posts come in a choice of red, white, blue, yellow, black, or green



thumbnut color rings that help you readily identify a wide range of polarity. Standard units come in a natural-gray plastic with customized colors available on special order. All current-carrying parts are gold-plated brass. Miniature fluted-nut types are rated for 15A at 1000V, and standard hex-nut and fluted-nut types are rated for 30A at 1000V. Hex-nut and fluted-nut types are also available with larger stud sizes. The thumbnuts have a positive stop, which allows enough space to make a connection and reduces the likelihood of accidentally touching an electrically energized surface. \$1.01 to \$1.80.

**Superior Electric Co, 383 Middle St, Bristol, CT 06010. Phone (203) 582-8098. FAX 203 589-2136. TLX 962446.**

Circle No 619

## TOOL KIT

The JTK-1001 Clean Room Kit consists of more than 100 tools for maintenance and repair of clean room equipment. The case is made of high-density polyethylene, and it has a molded-polyethylene handle



Text continued on pg 178



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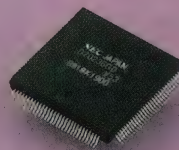
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## INTRODUCING V53: THE MS-DOS-COMPATIBLE, 16-BIT MICROPROCESSOR WITH A 400% PERFORMANCE EDGE



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The new V53™ meets your needs with the powerful V33™ CPU – rated four times higher in overall performance than the V30™ CPU. The V53 also integrates all basic peripherals on-chip to maximize system speed and minimize circuit board size.

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If you're determined to design an outstanding system, choose the 16-bit microprocessor with the courage to stand out. The V53 from NEC.

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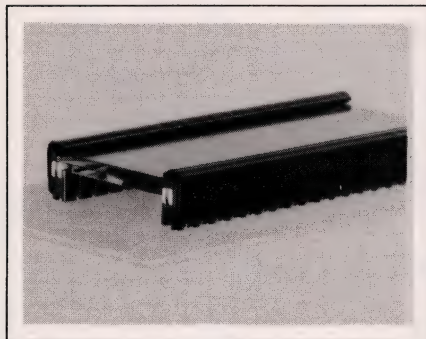
# Hardware and Interconnect Devices

and a polyethylene retaining strap. A tongue-and-groove closure features an O-ring gasket that seals out dust and moisture. The kit also has a combination lock and two keyed latches for security.

The tool palettes feature transparent pockets for easy tool selection. Each pocket has a drain hole and the entire palette can be cleaned in a tank or by hand. The kit contains all the standard inch-measure tools for servicing process-control instruments, test equipment, computers, and communications systems. JTK-1001, inch-measure version, \$455; JTK-1002, inch/metric version, \$580.

**Jensen Tools Inc, 7815 S 46th St, Phoenix, AZ 5399. Phone (602) 968-6431.**

Circle No 620

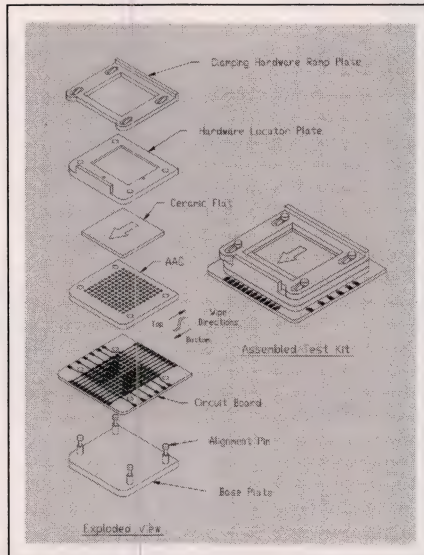


## LCD CONNECTOR

The LCD Series hybrid connector connects LCDs to pc boards and combines the advantages of pin-and-socket with the advantages of elastomeric connectors. One standard connector can accommodate LCDs as long as 4 in. with any centerline-spacing widths. A snap-strip feature allows you to build short-length connectors in multiples of 0.1 in. The elastomeric connection provides a cushion against vibration and shock. The pin-and-socket connector is a zero-insertion-force connector. \$0.10 to \$2.50 (100).

**Samtec Inc, Box 1147, New Albany, IN 47150. Phone (812) 944-6733. FAX 812-948-5047.**

Circle No 621



## ARRAY CONNECTOR

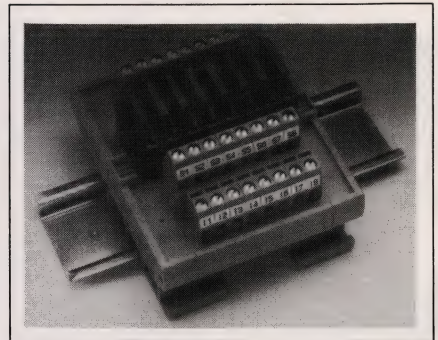
The Area Array Connector provides an interconnection between a pad-grid array package and a circuit board without using pins or soldering. The connector consists of rectangular conductors inserted into a cellular elastomeric sheet. Two contact-pad arrays compress the sheet to make contact with the conductors. The conductors pivot on their axes during compression to produce a controlled contact force. Each electrical contact has a resistance of  $<5 \text{ m}\Omega$  per I/O. The connector can be used with multichip modules or single chips and can work at digital speeds of more than 100 MHz. \$0.10/contact; test kit, \$400.

**Rogers Corp, 1 Technology Dr, Rogers, CT 06263. Phone (203) 774-9605.**

Circle No 622

## CONNECTION SYSTEM

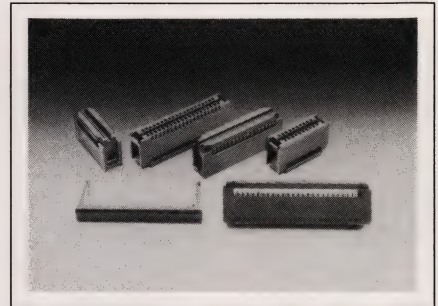
The FLKM-8-GMT interconnection system joins discrete wires. The module has screw-clamp terminal blocks that reside in a shock-proof housing. The terminal blocks accept discrete wires as large as #14 AWG wire. The module also accommodates as many as eight GMT fuses that can transmit a blown-fuse indication signal to a programmable logic controller. The GMT fuses can



have individual ratings of 0.18 through 10A. The unit also has a universal foot for convenient mounting on any DIN rail. From \$50.

**Phoenix Contact, Box 4100, Harrisburg, PA 17111. Phone (717) 944-1300. FAX 717-944-1625.**

Circle No 623



## CARD CONNECTORS

You can use the 636 Series card-edge connectors to install flat-cable interfaces on double-sided pc boards. The connectors are available in three mounting configurations: with full- or half-mounting ears and without mounting ears. A strain relief is available for connectors with no mounting ears. The series comes in 9 connector sizes: 10, 16, 20, 26, 30, 34, 40, 50, and 60 positions.

An integral side latch ensures positive crimping and keeps the assembly intact during and after crimping. Self-aligning cable guides ensure virtually error-free contact alignment. The contact mating area has a minimum of 15  $\mu\text{in.}$  of gold plating. A polarizing key is optional, and it locks securely into the body of the connector tabs. The con-



# Bendix® Connectors — tomorrow's technology today.



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For more information on the Bendix® programmable – removable transient protection system

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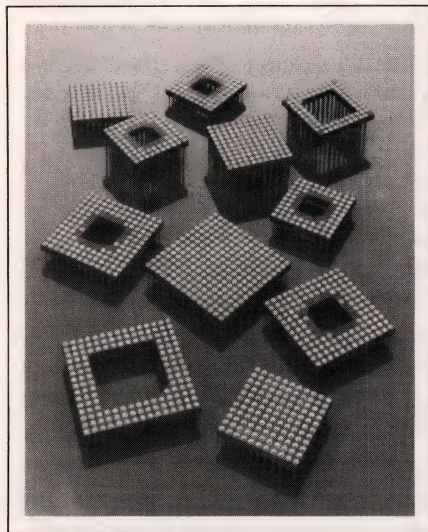


# Hardware and Interconnect Devices

nectors are constructed from a thermoplastic that is 94V-O UL rated. \$1.08 (1000). Delivery, six to eight weeks ARO.

**Thomas & Betts Corp, Electronic Div/Technical Service, 1001 Frontier Rd, Bridgewater, NJ 08807. Phone (201) 685-1600. TLX 833190.**

Circle No 624



## PGA SOCKETS

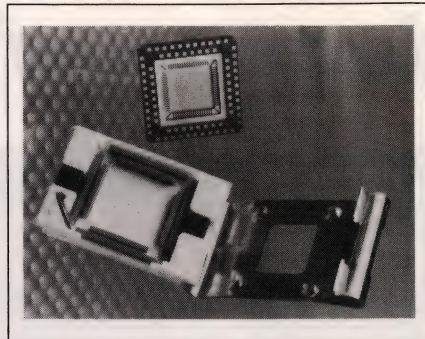
The UXP Series consists of molded pin-grid-array sockets. The mold is a glass-filled thermoplastic polyester that conforms to the 94V-O UL rating. The sockets come in all standard and some custom configurations, and in grid sizes ranging from 10×10 to 18×18 receptacles. A wide variety of soldertail and wire-wrap terminations are available. An optional staggered-entry contact arrangement produces an average insertion force of 1.75 oz/line. Another option for molded standoffs aids in soldering.

Some mechanical specifications include a 2.9-oz insertion force, a 0.5-oz withdrawal force, an average contact pressure/pin of 1.5-oz normal force, an operating temperature of -50 to +125°C, and a minimum durability of 25 cycles. Electrical specifications include a 1A/contact maximum operating current, a dielectric voltage of 600V

rms, a pin-to-pin capacity of <0.4 pF, and a contact resistance of <20 mΩ. 68-pin socket, \$3 (100). Delivery, stock to eight weeks ARO.

**Precicontact Inc, Box 798, Langhorne, PA 19047. Phone (215) 757-1202. TLX 834253. FAX 215-757-8025.**

Circle No 625



## DISK-DRIVE CHASSIS

The SA-H116/2 chassis provides power and mounting for as many as three 5 1/4-in. disk drives. Two drives that show through the front panel allow you to use removable-media drives such as tapes and optical and floppy disks. A filler panel covers the unused slot for applications involving only one drive. The third drive also mounts near the front of the chassis but is concealed behind the front panel. In order to meet FCC requirements, the unit includes shielded connector data cables. The standard chassis connector configuration provides two 50-pin D subminiature connectors for SCSI in and out. Other configurations are available. The H116/2 includes a 200W power supply and two fans. The supply operates from either 115 or 230V ac inputs and includes an unswitched ac outlet. \$586.

**Sigma Information Systems, 3401 E LaPalma Ave, Anaheim, CA 92806. Phone (714) 630-6553.**

Circle No 626

## CARRIER AND SOCKET

The model 363 carrier-and-socket combination uses solderless elastomeric interconnections and is designed to replace pin-grid arrays and conventional leadless ceramic chip carriers where high-speed and high-density ICs are used. The land-grid-array socket connects to a 76-pin LCCC that's only 650 mil square. The LCCC achieves its small footprint by having two rows of contact pads around its perimeter

instead of the conventional one row. Connections are made through elastomeric connectors that provide low inductance and a low profile.

The socket is fastened to the board by two plastic connectors, and the LCCC is held in place by a stainless-steel snap lid that compresses the elastomeric connectors, making a gas-tight seal. You can insert the LCCC upside down so its metalized case can serve as a ground plane. A cut-out area in the socket lid accepts a heat sink, if necessary. \$8 to \$10 (1000). Delivery, six to eight weeks ARO.

**Elastomeric Technologies Inc, 2940 Turnpike Dr, Hatboro, PA 19040. Phone (215) 672-0787. TLX 387236. FAX 215-672-4633.**

Circle No 627

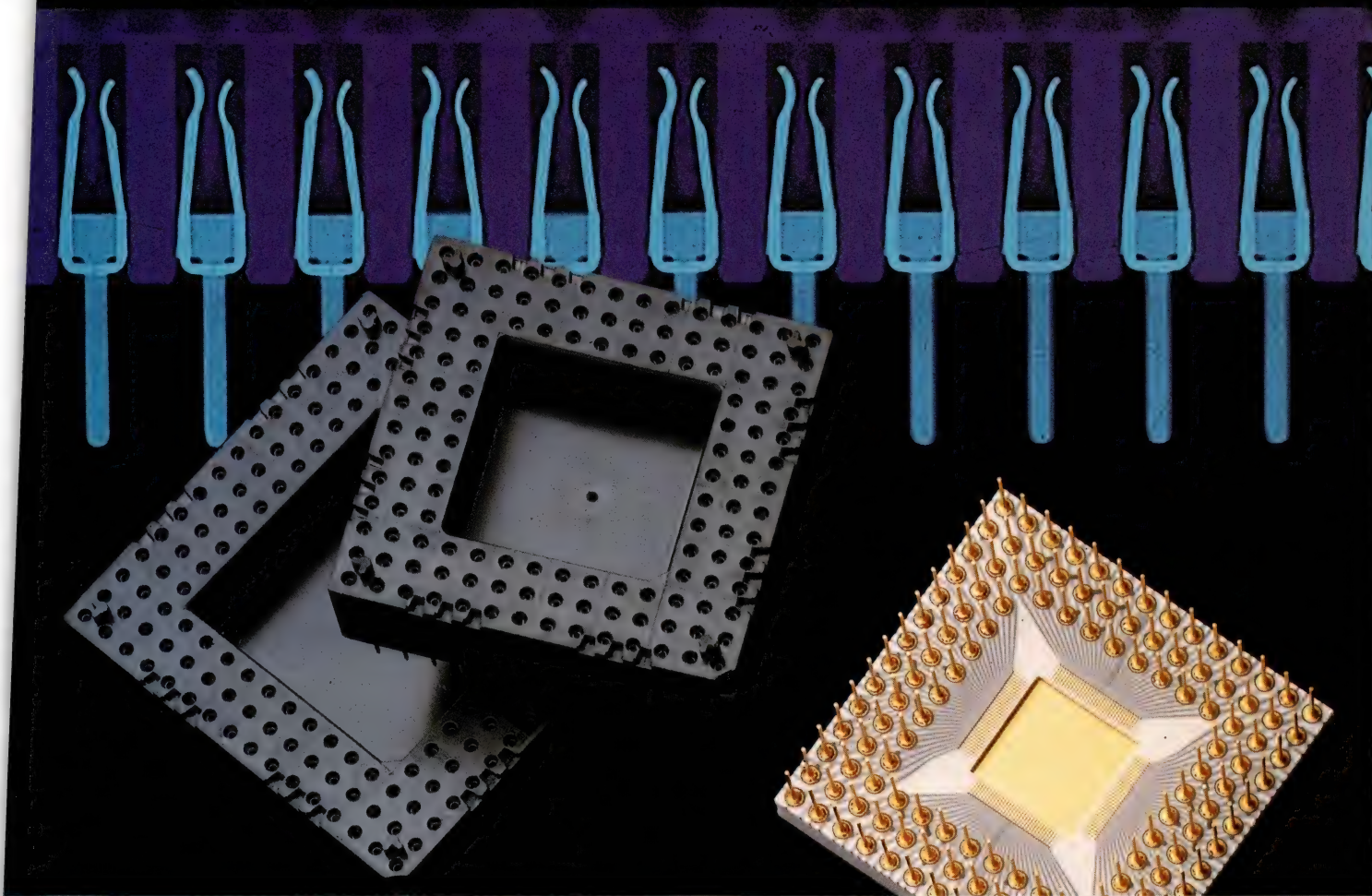
## ZIP CABLE

Thermoplastic elastomer (TPE) insulated zip cable is available in sizes from 10 through 64 conductors. The thermoplastic elastomer insulation allows you to operate this cable over -65 to +125°C. Cable construction consists of #28-7 AWG tinned-copper conductors on 0.05-in. center spacings. One edge of the cable is marked for polarity reference. UL recognized at a rating of 125°C and 300V, the cable is available on 100-ft put-ups. A 10-conductor cable, \$18.69 (10).

**Amphenol Spectra-Strip, 720 Sherman Ave, Hamden, CT 06514. Phone (800) 572-2253; in CT, (203) 281-3200.**

Circle No 628





## A revealing look at the difference in high performance IC interconnect systems.

The X-ray of our LIF Pin Grid Array socket is our way of emphasizing that it's what's **inside** an IC interconnect that makes the difference — in performance, reliability, and protection for your valuable IC devices.

To help you make the best choice in IC interconnects, we offer a close look at our new LIF Pin Grid Array socket — it's typical of the engineering quality that we build into our IC interconnect systems.

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- Low insertion (1.7 oz. avg.) and low withdrawal (1.3 oz. avg.) forces, plus high normal force (64 grams/min.) provide for easier insertion/extraction, and maximum performance.
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- Anti-wicking contact design keeps solder where it belongs — on the solder joint.
- Top-side standoffs prevent contact damage due to over-insertion.

- Our LIF PGA socket is low profile, oriented for robotic placement, and available in standard or custom pin configurations in grid sizes from 10 x 10 through 16 x 16.

### The company behind the product

A close look at our company will reveal our strong financial position, our commitment to the future, and our ability to support you worldwide. Write for our Annual Report — it's like an X-ray of our company.

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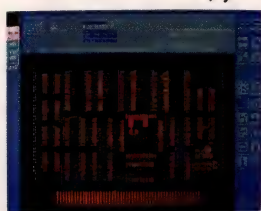
## **Thomas & Betts**





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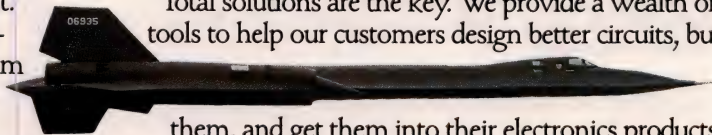
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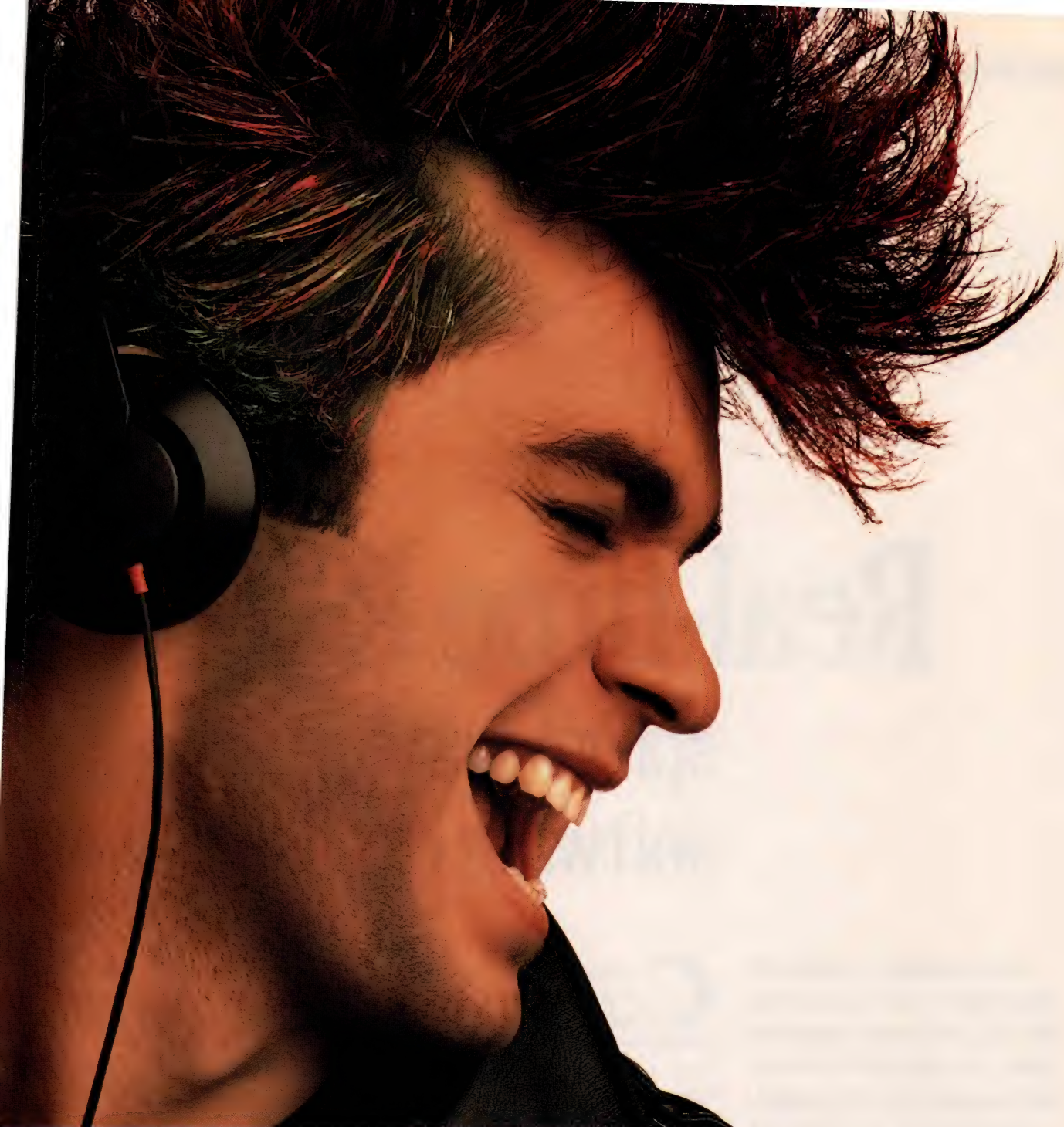
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CIRCLE NO 109



# Real-time kernels sprout into full-grown software environments

**Two groups of software engineers, both unused to formal, real-time software tools, are poised to invade and overwhelm the small, cozy realm of real-time kernels.**

Charles H Small,  
Associate Editor

**C**urrently, software engineers do the overwhelming bulk of their real-time programming using home-brewed software systems. But two teeming hordes of programmers are just now beginning to migrate to formal, real-time software tools such as real-time kernels. These two groups are assembly-language programmers and high-level-language programmers. At present, the high-level-language programmers are mostly Unix wizards who program in C. The ranks of C programmers writing real-time code for embedded systems will soon be swelled, if not overwhelmed, by a torrent of Ada programmers hewing to the Department of Defense's software-language mandate.

Each group brings with it a dif-

ferent set of strengths and weaknesses, a different mix of skills and knowledge gaps, and distinct areas of interest. Both groups are moving toward formal real-time tools for the same reason: Embedded systems having fast, powerful processors and vast memories permit software systems that are too big and too complex to be written with ad hoc, low-level, unverified software tools.

Getting a real-time kernel couldn't be easier. Many OEM computer-board makers, such as Motorola and Force, offer a variety of targeted, ready-to-go real-time kernels as check-off items for their CPU boards. Force, for example, offers its VMEPROM, which is a version of Eyring Research's PDOS. VMEPROM includes a de-





bugger similar to Motorola's industry-standard MAXbug. Force also supplies the Software Component Groups' PSOS in EPROM, as well as Wind River Systems' VxWorks, and Ready Systems' VRTX as board-support packages. Similarly, all real-time-kernel vendors have targeted versions of their kernels—or "ports"—for common OEM CPU boards.

#### Roll your own

If you're designing your own  $\mu$ P system, you can avoid using OEM boards by having real-time kernel vendors supply you with versions of their kernels for most  $\mu$ Ps. These vendors have written drivers for many  $\mu$ P-support chips; the drivers are not a resource to be taken lightly, as anyone who has tried to

write a driver for Zilog's 8530 dual-serial controller, using only Zilog's documentation, can testify.

Makers of full-fledged, real-time operating systems sound a note of counterpoint, however, to the usefulness of the very notion of a real-time kernel. Alycon, maker of Regulus, Digital Research, maker of FlexOS, and Microware, maker of OS/9, note that their Unix-like, real-time operating systems are made up of re-entrant modules. Thus, they claim, you can easily strip their full-featured operating systems to encompass only that bare minimum of facilities provided by a skeletal kernel. They also point out that with the exception of Boston Systems Office, kernel makers are offering such operating-system add-ons as file systems, multipro-

**Real-time software powers the real world**  
(Forth Inc)



**Software engineers are moving toward formal real-time tools because embedded systems are getting too big for low-level, unverified software tools.**

cessor support, local-area-network communications packages, graphics packages, and debuggers.

Kernel makers now offer these add-ons because many embedded systems no longer operate stand-alone with only rudimentary user interfaces. Embedded systems are being linked with local-area networks, large databases, and often require powerful, graphics-oriented user interfaces for control and information display.

And, as always, Forth stands alone. Forth Inc's PolyForth provides even less built-in facilities than a kernel. PolyForth has built-

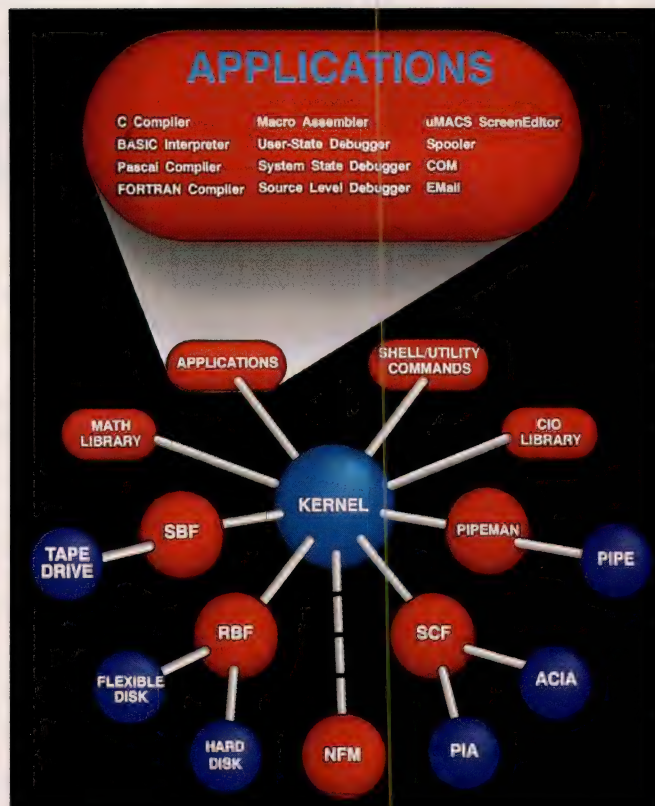
the entire PolyForth system, comprising operating system, editor, and compiler, is as small as many kernels. Forth programmers bravely challenge others to write real-time systems that are smaller and faster than theirs.

As for real-time kernels—they are not all created equal. Even now, several standards committees are laboring, probably in vain, to standardize software interfaces to real-time kernels. These efforts are arguably doomed until widespread acceptance and use of real-time kernels winnows the range of available real-time kernels and their attendant diversity of features down to a manageable set of more-or-less similar products.

Currently, despite the fact that all real-time kernels perform the same two basic real-time functions of multitasking and intertask coordination, no two kernels do these jobs in quite the same way. You can, in some instances, tell by inspection that some real-time kernels have facilities that others do not. For example, no other real-time kernel has the controlled-shared-variable feature of Industrial Programming Inc's MTOS.

But beware! Many features of various real-time kernels appear, at least on the surface, to be similar. They are not. Two factors hamper your efforts to penetrate the jungle of alien jargon used in real-time programming: inadequate metaphors for real-time operations and lack of uniformity in implementing similar operations among different real-time kernels.

Take, for example, the simplest real-time mechanism, the so-called "semaphore." In real life, a semaphore is a visual signaling apparatus that has lights, flags, or mechanically moving arms. Railroads use them to signal locomotive engineers. In real-time kernels, semaphores have such starkly different



**Add-on modules expand kernel to operating system (Microware Systems Corp)**

in multitasking, in the form of its pF/x operating system, and Forth words for controlling tasks. But it has no intertask communications constructs comparable to the semaphores, flags, mailboxes, etc of other real-time kernels. And yet,



uses and properties that the metaphor reveals itself to be quite inadequate.

Real-time programmers use a semaphore for both simple signaling *and* for controlling tasks' access to shared resources, such as a disk, printer, or I/O port, which can be used safely by only one task at a time. Thus, a semaphore can function like a bus-grant signal in a hardware system.

Unlike a railroad semaphore, requesters queue up at a software semaphore. The requesting task at the head of the queue blocks all the other tasks in the queue from running until it relinquishes its place at the head of the queue. Thus, a real-time programmer can, for example, guard a shared memory area with a semaphore. This guarding can eliminate race conditions, such as those that occur when one task starts reading from a common memory area before another task finishes updating the area's data.

In addition to not operating like a real semaphore, real-time-kernel semaphores display a range of ingenious variations. First, consider the semaphore's queue. Some real-time kernels, and Ada, use a simple-minded, and possibly fatal, first-in, first-out (FIFO) method of ordering requesters in the semaphore's queue. This scheme, under some circumstances, could cause your system to lock up or crash.

### Dynamic priority adjustments

More sophisticated kernels employ a prioritized queue, which allows more urgent requesters to move ahead of low-priority tasks. Still other, more canny real-time kernels have subtle mechanisms for dynamically changing the priorities of tasks in the queue.

For example, Intel's iRMK has a cryptically named "region" function. This function will change the priorities of all requesters in a

queue to the priority of the highest-priority task in the queue. This change keeps low-priority tasks from blocking high-priority tasks.

Industrial Programming's MTOS real-time kernel allows you to infect tasks with anxiety. That is, the longer the task goes without running, the higher its priority becomes.

Real-time kernel designers claim you need these dynamically changing priority schemes because, in many commonly encountered real-time situations, tasks will sometimes be blocked no matter how you assign relative priorities *if* those



**A real-time kernel controls this chemical analyzer (Industrial Programming Inc)**

priorities remain fixed.

The same situations occur with another common real-time construct: the mailbox. Real-time mailboxes don't work very much like the ones you encounter in the Post Office. In the real world, only the boxholder can get mail from a mailbox. Also, the boxholder can receive different-sized messages through his mailbox.

Real-time mailboxes can have queues for both posting and *receiving* messages. Naturally, just as with semaphores, the methods for ordering tasks in these queues



**Several standards committees are laboring, probably in vain, to standardize software interfaces to real-time kernels.**

vary. Thus, not only can any task post a message at a mailbox, any task can receive a message from a mailbox instead of restricting receiving to just a single boxholder. And, what's more, mailbox messages usually come in fixed sizes because real-time kernel designers find that fixed-length message buffers are easier and faster to manage than variable-length buffers.

Once you get beyond these at least commonly named, if not commonly acting, functions, real-time kernels have an amazing array of noncompatible, unusual features.

Real-time kernels not only differ in the functions their operating-system calls perform, they even differ

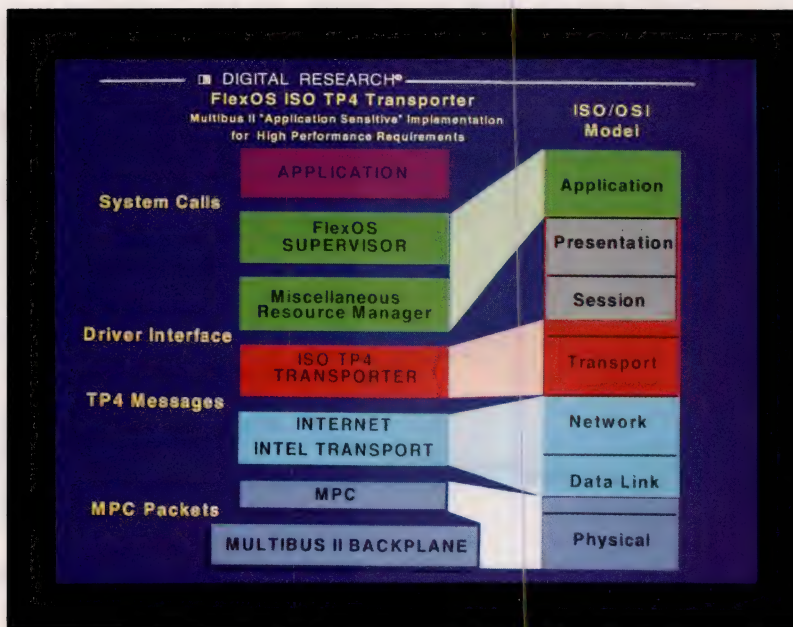
The original purpose of using the software-trap mechanism for kernel calls was to make the real-time kernel a so-called "software component." Because the entry points, or "hooks," to the kernel routines are memory locations that are fixed by the processor's architecture, kernel makers could then supply the kernel in a fixed, preprogrammed PROM in much the same fashion as the operating system for a personal computer is supplied.

Do not confuse the software-component concept with ROMable code. All real-time kernel vendors are aware that their systems must live in the real world and function in stand-alone systems. Because stand-alone systems often have no mass storage, all real-time kernels are set up so that you can burn them into a PROM.

#### Detail ignites debate

Surprisingly, this seemingly minor implementation detail is the subject of a heated debate. Proponents of the subroutine-call method, such as JMI Software, claim their method meshes seamlessly with code written in a high-level language (in JMI's case, C). Their way, the real-time kernel is just another library routine that your linker can meld with your other software modules to form a software system. The software-trap mechanism, they point out, varies from processor to processor, eats up scarce processor resources, and requires additional overhead.

The software-trap call mechanism requires additional overhead, it is claimed, for two reasons. First, each high-level language has a specific way of passing parameters and commands to subroutines. Consequently, real-time kernels that use the software-trap mechanism often require you to go through an intermediary to get to the kernel's software trap. This intermediary con-



**Some real-time systems have optional packages for standard networks**  
(Digital Research Inc)

in the mechanism they use for performing an operating-system call itself. You invoke some real-time kernels via a software trap, and others use the native subroutine-call mechanism of the host processor. Real-time kernels that cater to high-level languages tend to view a kernel call as just another subroutine call; software-trap kernels treat a kernel call as a context switch to a godlike supervisory program.



sists of a set of library functions that resolve differences between a given high-level language's calling procedure and the requirements of the software-trap mechanism.

Second, because software traps are scarce resources, kernels that use the software-trap mechanism tend to use a small number of traps as gateways to numerous kernel functions. Therefore, the kernel's trap-handling routine must decode, or demultiplex, the commands and parameters that a calling routine passes, and vector execution to the proper system call. With a direct subroutine call, on the other hand, such demultiplexing is eliminated because the calling routine can call the desired kernel routine directly.

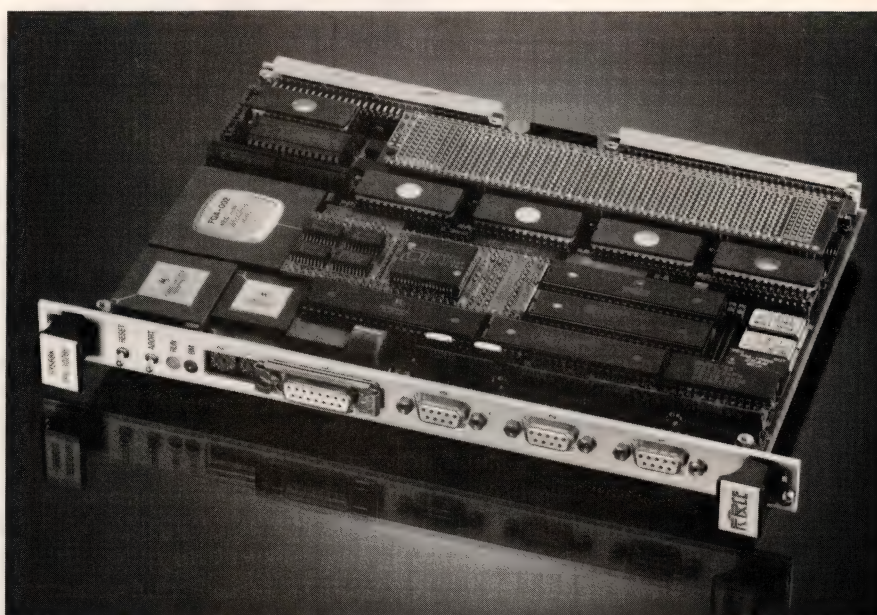
### Trap hogs

Proponents of the software-trap mechanism counter that although software traps are a scarce resource, no user has ever complained that their real-time kernels hog too many traps. They also point out that while software-trap mechanisms do, indeed, vary from processor to processor, subroutine-calling mechanisms, too, vary from language to language—and from compiler to compiler—even for the same language. In fact, subroutine-calling mechanisms can vary from one release, or version, of the same compiler for the same language.

As for overhead, high-level languages automatically impose overhead on a processor's native subroutine-call mechanism—overhead that's not visible to the high-level-language programmer but nonetheless is very real. So that while an intermediary routine must shuffle parameters and commands such that high-level languages' kernel calls will match the requirements of a given software-trap mechanism, high-level-language compilers do much the same sort of machinations in the machine language they

generate before invoking a processor's subroutine-call instruction. In other words, overhead is overhead no matter which mechanism the kernel uses for function calls.

Software-trap proponents further propound that you cannot add modules or functions to a linked system without relinking and reloading. You can judge whether or not this constraint is a major problem from the fact that Wind River Systems,



which has a linked system, has a method of working around this problem. During development, you can dynamically link in additional modules or functions via a table-look-up facility. For your final runtime version, you strip out the table-look-up facility and let your linker hook your function calls directly to the kernel routines.

Lastly, software-trap proponents point out that many processors' software traps automatically entail changes in status from user to supervisor, and changes in memory privileges. These automatic status changes are just the ticket for both error handling and a robust context switch from task to kernel.

Not all kernel designers make use

**Computer boards come with real-time kernels**  
(Force Computers Inc)



**No two kernels perform the same two basic real-time functions of multitasking and intertask coordination in quite the same way.**

of such powerful, built-in processor facilities for context switches. Intel's iRMK real-time kernel for the 80386 resides in one memory segment and runs at one protection level. On the other hand, Ready Systems's VRTX32 uses the 80386's built-in memory protection and status-changing mechanisms for context switches (but not the 80386's context-switch instruction, which has proved to be too cumbersome for real-time applications).

Real-time kernel designers also

debate the virtues of writing their kernels in a high-level language or in an assembly language. There's no consensus. Some small kernels, such as JMI Software's C Executive, are written in high-level languages, while some large real-time operating systems such as Micro-ware's OS/9, are written in assembly language. (Keep your eyes peeled for an OS/9 port to the 80386.)

Currently, when kernel makers say their kernels suit high-level lan-

## Self-help resources appear slim

How does a tyro begin to master real-time programming other than learning, if at all, by painful trial and error? Remember: The best way to learn a bad habit is to practice it over and over; just because you've previously made errors doesn't necessarily mean you learned anything useful from them. Universities are not much help. Few courses, if any, exist that teach real-time, embedded-system programming.

Although many of the real-time kernel vendors listed in this article are just mail-order houses, some (for a fee), will act as consultants to your firm. Some also offer seminars. You can naturally expect such seminars to be like all other vendor-sponsored seminars—biased toward the vendor's products. Further, the seminar will probably accentuate the host company's product's good points, while minimizing any deficiencies the product has, or difficulties you, as a beginner, may encounter.

### Skilled customers

Most vendors offer help phone lines, and some have field-application engineers. But until recently, these vendors have enjoyed working with customers who were generally as skilled or more skilled than the vendors are in real-time programming. Most vendors do not have application literature that even begins to approach the high-quality, extensive application literature of hardware vendors.

Any comparison of the application literature of hardware vendors, such as Analog Devices or Hewlett-Packard, with real-time kernel vendors' invariably leaves the software literature looking pitifully inadequate.

Self-study opportunities are limited, too. Most texts on real-time programming are very academic. Reading these texts, you will become very familiar with such abstruse topics as the "Dining Philosophers' Problem." Apparently, despite years of furious effort and cogitation on the part of multitasking theoreticians, no one can ensure that a bunch of absent-minded philosophers will all get something to eat.

As fascinating as this problem is, your real-time system will probably be feeding no philosophers. More practical is the soon-to-be-published, "An Implementation Guide to Real Time Programming" by David L Ripps, Prentice Hall, \$39. Ripps, one of the developers of Industrial Programming's MTOS and a long-term Industrial Programming employee, naturally uses MTOS in all his examples. But this focus shouldn't be a problem because MTOS has more features than any other real-time kernel; the book should prove helpful no matter which kernel you use.

Andyne Computing Ltd's PCMASCOT real-time operating system for the IBM PC costs \$795 and comes with an excellent manual. The manual presents a detailed series of application examples of increasing complexity. After working through the examples, you should be able to acquire a good, basic feel for intertask communication and control.

But, even with PCMASCOT background, you will still have to master three other vital, basic areas of real-time programming on your own: dividing an application into tasks, setting priorities, and testing and fine-tuning the system.



guages and operating systems, they really mean C and Unix. That is, their kernels' calls look like C subroutine calls; their command syntax, string handlers, file and I/O routines, and communications methods look, as much as possible, like Unix ones. For example, they would substitute message queues for Unix pipes and allow programmers to "fork" threads of a program instead of requiring them to fork the entire program.

Obviously, not everyone programs in C; more to the point, Ada syntax differs from C syntax. And the Ada specification doesn't just mandate a compiler. The full Ada specification defines a complete computer-aided software-engineering (CASE) development environment and runtime environment which differs from, and covers areas ignored by, C and Unix.

Cooking up a kernel call to handle Ada's rudimentary "rendezvous" function for intertask coordination is not difficult, yet so far only Ready Systems and Industrial Programming have done so. You can expect other kernel vendors to jump on the Ada bandwagon soon. Luckily, Ada allows you to use, or "import," non-Ada routines. Therefore, Ready Systems' and Industrial

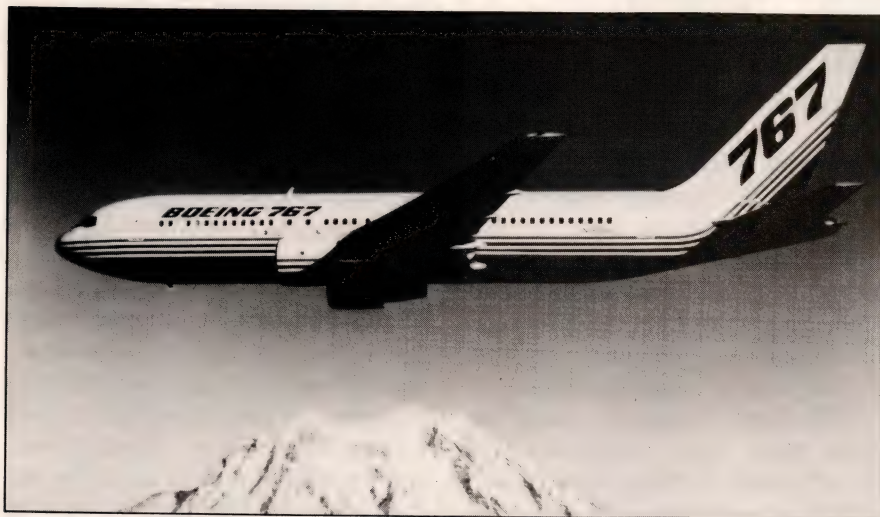


Programming's Ada-compatible kernels offer all of the companies' usual kernel calls in addition to the Ada rendezvous.

Comparing different real-time kernels, for all the preceding reasons, is therefore a difficult job for the uninitiated.

The difficulties experienced by software engineers new to real-time kernels depend on the engineers' backgrounds. Because of their intimate association with hardware, assembly-language programmers are, on the one hand, very comfortable with low-level minutiae such as set-

**Real-time systems handle local-area-network communication** (Microware Systems Corp)



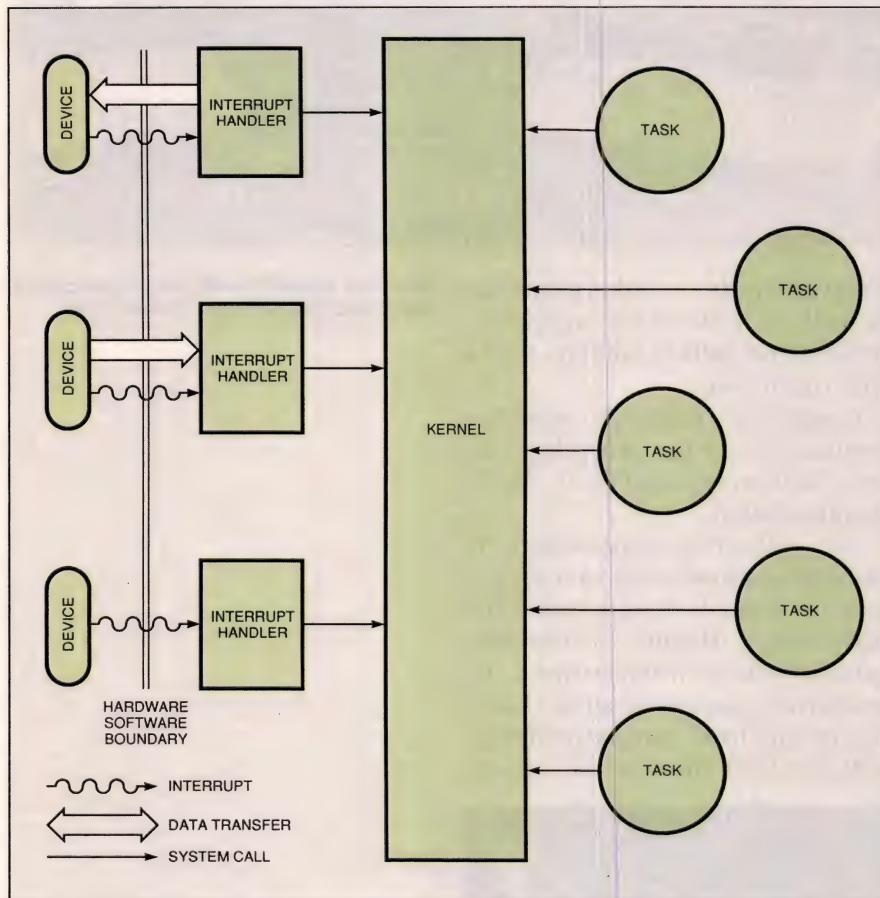
**Modern aircraft depend on real-time kernels** (Ready Systems)



## Inadequate metaphors for real-time operations hamper your efforts to penetrate the jungle of alien jargon used in real-time programming.

ting and clearing flags, using timers, and handling handshaking between independent processes. They also have no trouble grasping the rationale behind the style of tasking, which posits a software task for every real-world process that the software must monitor or control.

Assembly-language program-



**Real-time kernels mediate between the real world and software (Ready Systems)**

mers have difficulties, on the other hand, with classical control and data-flow problems such as corrupted data or two tasks getting locked in a fatal embrace. (A fatal embrace results from two processes blocking each other, each one waiting for a reply from the other.)

High-level language programmers have fewer problems with data-flow but correspondingly more problems with low-level real-time-kernel functions. And because the

cost of spawning a new task ("forking") is high under Unix, Unix wizards tend to write monolithic programs that could be better broken up into a number of small tasks. Real-time-kernel context switches are much faster than Unix context switches; real-time tasks are orders of magnitude smaller than Unix tasks. Unix programmers are amazed when shown that a task occupying only a few hundred bytes of memory and comprising a couple of lines of code can, in fact, do useful work.

Further, while the Unix forking model has some elegant properties that prove useful for certain applications, forking is a cumbersome, unwieldy model for real-time programming. To fork a task, Unix must make a copy of the entire task. The "child" process thus forked off inherits all the properties and I/O privileges of its "parent." So rather than actually comporting with the parent-child metaphor commonly employed by Unix programmers, forking more closely resembles cloning.

Unix programmers are used to the "pipes" mechanism for passing data between processes and are often uncomfortable, at first, with the less flexible, but faster, mailboxes and message queues provided by some real-time kernels.

### Shared data is a moving target

Also, experienced high-level-language programmers who are familiar with data-flow design commonly have designed software systems whose tasks acquire a set of data, modify it, and then pass the complete set of data on to another task for further processing. In contrast, data sets in real-time systems often have several tasks working on them at one time. Thus, although software pundits promote data-flow design as both the best structured software-design method and the



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**Real-time kernels differ in the functions their operating-system calls perform and in the mechanism used for an operating-system call itself.**

ideal model for CASE tools, data-flow designs match up poorly with many real-time kernel facilities.

Reportedly, neither assembly-language nor high-level-language programmers understand the power and pitfalls of a pre-emptive scheduler. They will all have to leave behind them their timing diagrams and flow charts and adopt new design aids.

**Metasolutions hard to come by**

The problem the uninitiated have in understanding and evaluating different real-time kernels is the same one faced by anyone who must

master a complex field—the novice's lack of "metasolutions." Any experienced designer, in any field, has general solutions, in his head, to common problems. Metasolutions transcend the low-level characteristics of the particular technologies that the designer works with.

For example, an experienced logic designer knows general ways to solve logic problems. He will search through the manuals describing a particular logic family until he finds the bits and pieces that will realize his metasolution. Often, the solution to a "metaproblem" involves using a particular device in

**For more information . . .**

For more information on real-time kernels such as those described in this article, circle the appropriate numbers on the Information Retrieval Service card or use EDN's Express Request service. When you contact any of the following manufacturers directly, please let them know you saw their products in EDN.

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Canada  
(613) 548-4335  
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Manhattan Beach, CA 90266  
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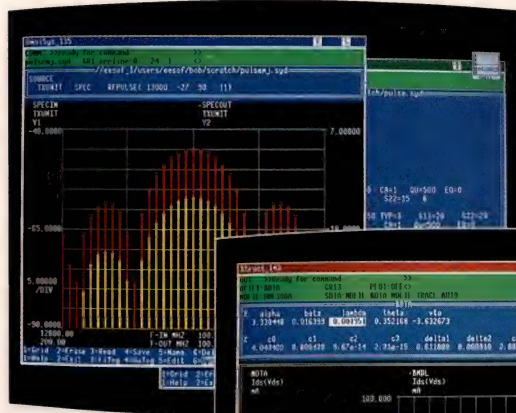
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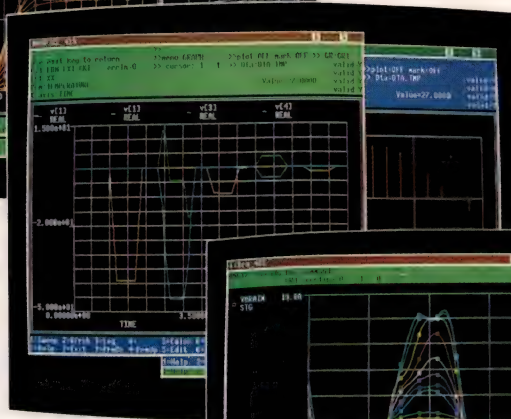
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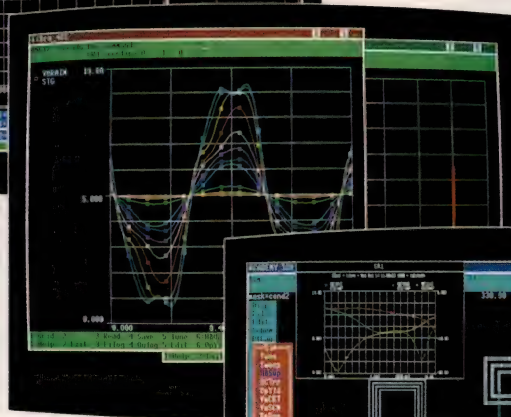
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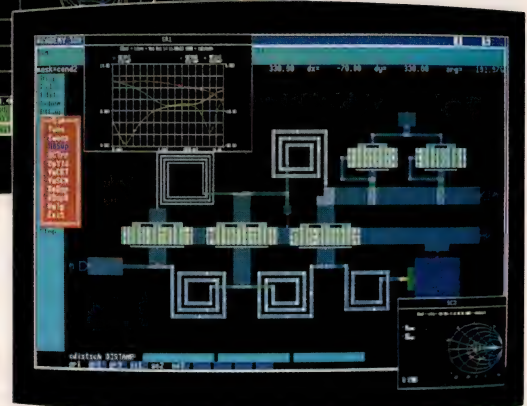
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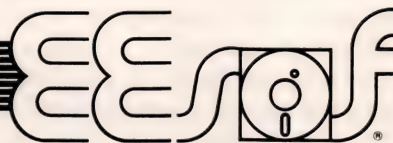
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**Not all kernel designers make use of powerful, built-in processor facilities for context switches.**

an unusual manner not envisioned by its designer.

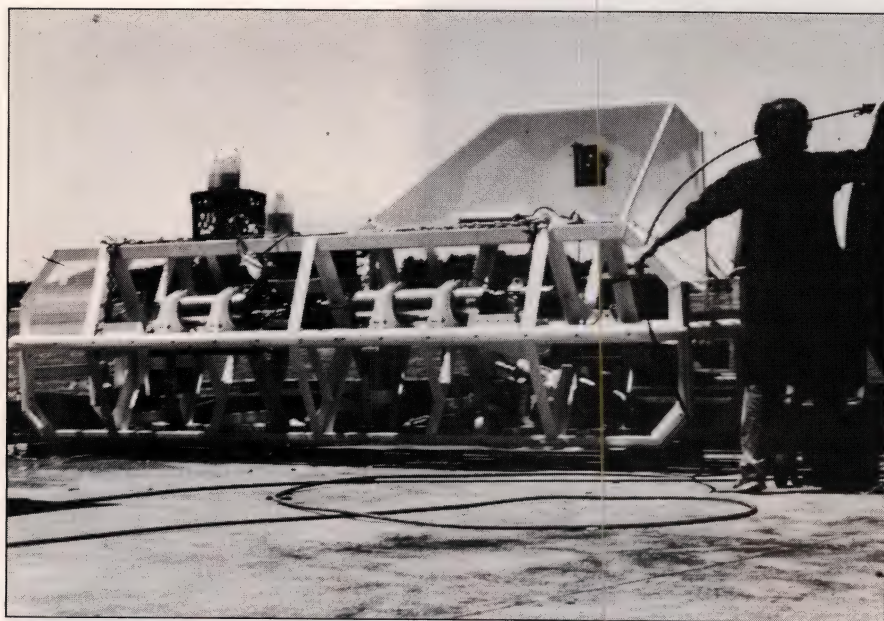
Similarly, an experienced assembly-language programmer can pore over the instruction set of a new processor to find which instructions he will use, in a particular order, to solve a particular metaproblem. High-level-language programmers do the same with different high-level languages.

This notion of metasolutions underlies the saying about programming languages, "You can write bad code in any language," and its corollary, "The best language and oper-

switch. This specification measures how long the kernel takes to respond to a request from a task. One real-time kernel could have a much faster context switch than another. But suppose that the former's system calls were less powerful than the latter's. In this case, a task might have to issue more kernel calls to the faster, but less-powerful kernel, than to the slower one, to solve a metaproblem. In the final analysis, the "faster" kernel could end up being slower.

Consider a common real-time metasolution, the server task. A typical application for a server task is shepherding a shared resource such as a disk memory. Such a task will have to accept requests from several tasks, prioritize the requests, manage memory buffers, move data to and from the buffers and the disk, and notify requesters when their service call has been completed. Implementing and operating a server task can use a sizable fraction of the service calls that a real-time kernel provides. The overall efficiency and robustness of the server task will be an amalgam of the characteristics of *all* the service calls that the task uses and responds to. Looking atomistically at a given real-time kernel's service calls will not tell you how well they can work together to realize a metasolution such as a server task.

**EDN**



**Undersea robot thinks with real-time brain**  
(Ready Systems)

ating system for your project are the language and operating system that your best programmer likes best."

Without a clear idea of appropriate metasolutions, you can get lost in a welter of seemingly meaningless and unrelated characteristics of any particular field, be it a logic family, a  $\mu P$ 's instruction set, a high-level-language's reserved words and constructs, or a real-time operating system's service calls.

Take, for example, the specification for a real-time kernel's context

**Article Interest Quotient**  
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# How To Win The Real-Time Clock Game

Developing software for real-time applications can be a challenging game.

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CIRCLE NO 112



# Do you have to design in

RTAda; model: Robot controller

```

package body PANEL is

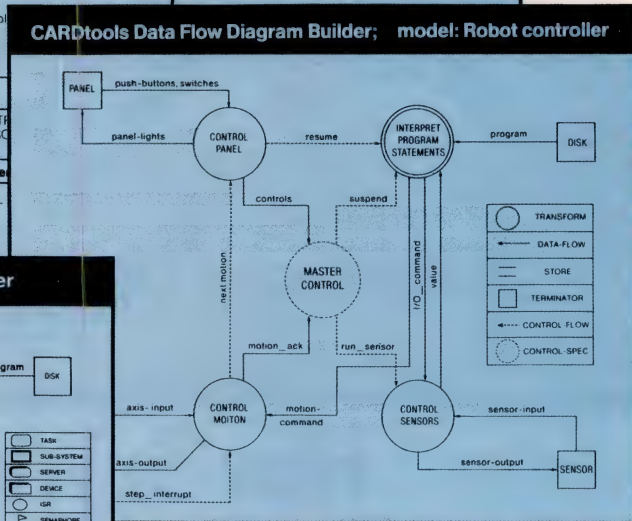
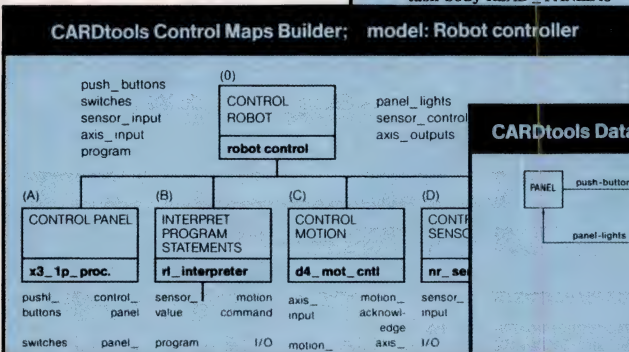
  task READ_PANEL is
    entry PANEL_INPUTS (STATE : in PANEL.STATE_TYPE);
    end READ_PANEL;

  task body READ_PANEL is
    ...
  end READ_PANEL;

end PANEL;
  
```

Coding and Remote Debugging

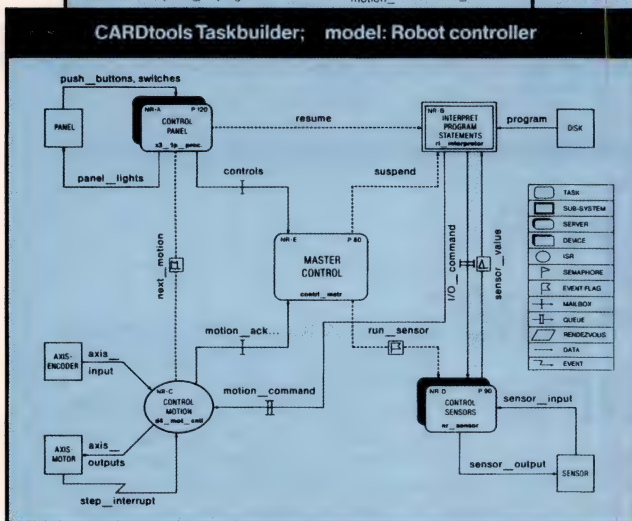
Detailed Design



HYPERLINK

High Speed Downloading

Requirements

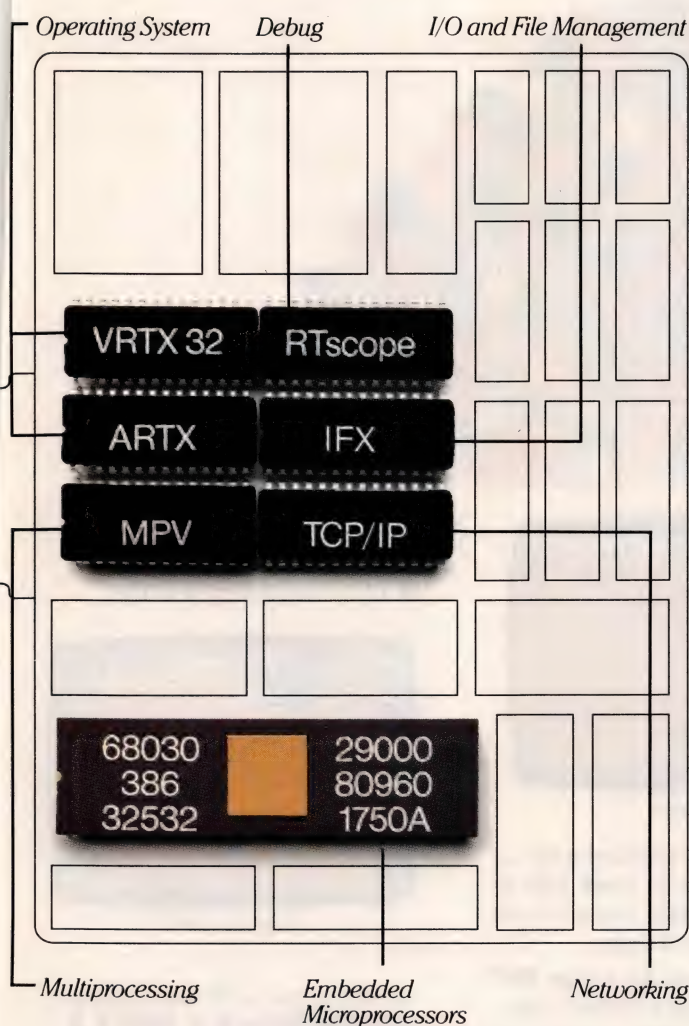


High Level Design and Performance Analysis

HOST



# what it takes real-time?



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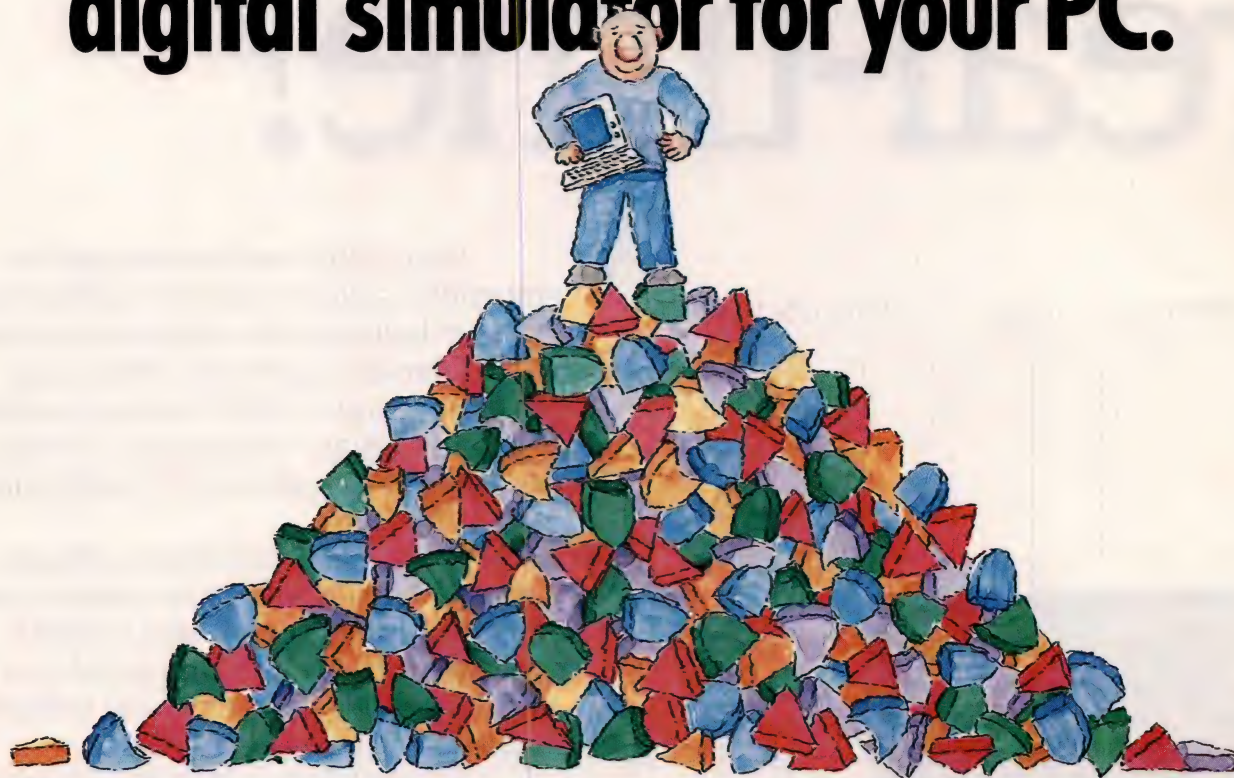
Because you can only be a success in real-time design if you've got the right stuff.

◆ **READY  
SYSTEMS**



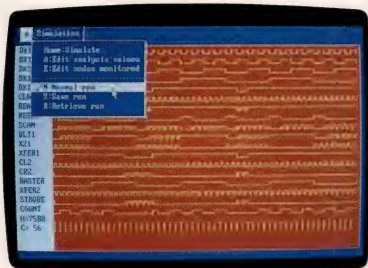
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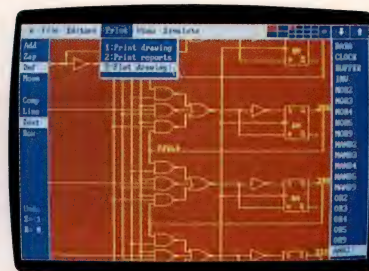
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## Real-time operating system assists in development of DSP-chip applications

Spox, a real-time operating system/development environment for the TMS320C30, is available to assist you in the development of applications for this DSP chip. As a real-time operating system, Spox provides a kernel that contains the executive and modules for memory management, stream I/O, and DSP math functions.

The kernel performs the task handling, scheduling, and message passing; consumes only 2k words of memory; and can switch a task in only 10  $\mu$ sec. The stream I/O module provides real-time device-independent stream I/O to ease the acquisition of data. The kernel, memory-management module, and

stream I/O module can all fit within the 4k-word memory on the TMS320C30.

Spox also includes various math functions and the hooks that allow any C program to use these functions. These math functions allow you to easily perform most common DSP applications.

As a development environment, Spox interacts with a host computer. You can write your algorithms in C and then test them on the host computer using a simulator that simulates the operation of Spox to verify timing and memory requirements.

You can run Spox in a C environment on an IBM PC or on a Sun

workstation to develop and evaluate your application code. The IBM PC version costs \$1000, and the Sun Workstation version sells for \$2000. It's also available bundled with the Texas Instruments XDS development system that lets you run your application using native code in real time. The development system is priced at \$16,000 with no additional costs. Later in 1989, Spox will be available as a linkable library for production use at a negotiable price.

**Spectron Microsystems Inc, 600 Ward Rd, Suite B-2, Santa Barbara, CA 93111. Phone (805) 967-0503.**

Circle No 434

## Real-time kernel written in C lets you port applications to different processors

RTXC (Real-Time eXecutive in C) is a real-time kernel for embedded systems that features multitasking, preemptive scheduling, intertask communication, partitioned memory, resource management, and timer management. Except for a small portion that handles interrupt processing, the executive is written entirely in C, so that you can use it for many different processors. You get the source code; therefore, you can modify it to suit the needs of a particular target system. The code is optimized for fast execution; on an 80286  $\mu$ P, a context switch requires only 50  $\mu$ sec. The complete package consists of the kernel, an interactive system-generation program (RTXCgen), and a system-level debugger (RTXCbug).

RTXCgen, which runs on an IBM PC/XT, PC/AT, or compatible, lets you define all system components



such as tasks, semaphores, queues, memory partitions, and timer data. When you've completed all definitions, the program generates C source code of all required system tables; you compile these tables and link them with the RTXC library and your application code.

RTXCbug can provide you with snapshots of system tables and com-

ponents so that you can see how they interact with the application. The program can also display performance statistics, showing you how much memory has been used, the worst-case stack usage, how many entries were made to a queue, and other helpful information.

The vendor distributes RTXC, RTXCgen, and RTXCbug in the form of C source code, together with a demonstration application, an executive function library, sample drivers, and a user's manual. A 1-time licence costs \$2995, and there are no royalties associated with continued use of the package by the licensee.

**A T Barrett & Associates, 11501 Chimney Rock, Houston, TX 77035. Phone (713) 728-9688. FAX 713-728-1049.**

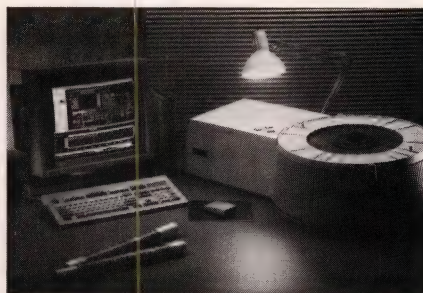
Circle No 435



## Software tools provide comprehensive test facilities for scan-path ASIC designs

ASIX-Scan is a menu-driven software package that lets you create test strategies for ASIC devices that you develop with scan paths. The package is intended for use with both the ASIX-1 development system and the ASIX-2 production test system, and it supports the IEEE P1149 bus-interface standard.

The program provides a large reconfigurable memory for storing scan vectors, and it includes sequencer instructions that let you shift the scan vectors into and out of the device under test. The program transmits the serial input data to the selected data-input pins, and receives device output for comparison with the expected result. Mode



1 uses a single scan vector, which can have 60M bits or more; this mode is helpful in applications in which test-bus pins have test-mode functions that are different from their normal-operation functions. In Mode 2, the program stores all the scan vectors in the scan-test module and can switch between scan mode and normal mode.

ASIX-TMP (ASIX Test Macro Processor) provides advanced program features that let you algorithmically derive device time, as well as stress-test CMOS ICs. Other features give you close control of the supervoltage test modes and let you implement tests for low-accuracy, mixed-signal devices. In addition, the macro processor lets you customize the menus and test programs. Both modules are available as options to the ASIX-2 test system. The ASIX-Scan Test Module cost \$50,000, and the ASIX-TMP macro processor costs \$8000.

**ASIX Systems Corp, 47338 Fremont Blvd, Fremont, CA 94538. Phone (415) 656-8664.**

Circle No 436

## Math package gives you extensive range of symbolic and numerical capabilities

PC MACSYMA runs on 80386-based computers under MS-DOS. It is a full implementation of MACSYMA, the mathematical-modeling software package that has hitherto been available only for mainframes. The package combines symbolic and numerical analysis to automate complex mathematical modeling applications such as symbolic solution techniques, symbolic approximation methods, symbolic preparation for numerical analysis, and the graphical representation of symbolic expressions and numerical data. The package is particularly suited for use in applications such as mechanical and electrical-circuit design, control theory, acoustics research, and plasma and atomic physics.

The capabilities fall into five ma-

major categories: arithmetic and algebra; calculus; foreign language interfaces; on-line help; and plotting. The arithmetic and algebraic functions include user-defined functions as well as 12 predefined functions such as Euler, gamma, psi, and zeta; both exact and approximate symbolic equation solutions; algebraic and trigonometric simplification; sums and products of series; and sets.

The calculus capabilities include differentiation and limits; integration; ordinary differential equations; Laplace and Fourier transforms; and vector and tensor analysis.

The foreign-language interface capabilities let you generate Fortran or C source code that implements your mathematical expres-

sions or equation solutions. You can also generate TeX code that will cause a graphics-printer subsystem to produce clean and accurate images of your mathematical expressions.

More than 1500 documented commands and options allow you to automate computations that are not practical using traditional methods. To run the program, you'll need an 80386-based computer that has at least 4M bytes of RAM and 40M bytes of free space on a hard disk. It costs \$2900 for single copies; qualified academic institutions can buy 10 copies for \$510 each.

**Symbolics, 8 New England Executive Park, Burlington, MA 01803. Phone (617) 221-1250. FAX 617-221-1099.**

Circle No 437



# Oops... You Just Keyed The Transmitter Into Your Spectrum Analyzer

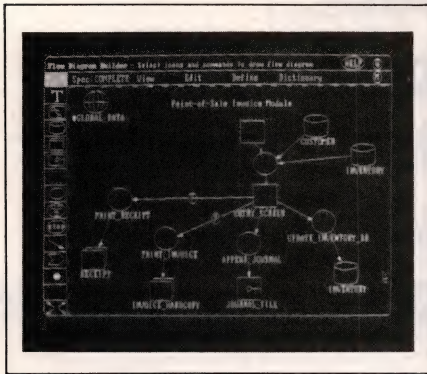
Costly and time consuming repairs due to accidental overload of your spectrum analyzer are now history. Rest easy...Marconi's 2382 uniquely features 50 watt front end protection. It also features full automatic self calibration, providing the industry standard for total level accuracy of  $\pm 1$  dB... including the integral tracking generator. That's right — you can count on this level of accuracy anywhere on the screen. To find out all the features of the 400 MHz and 4.2 GHz 2380 series spectrum analyzers, or to arrange for a demo, call toll-free 800 233-2955, in NJ (201) 934-9050 or write Marconi Instruments, 3 Pearl Ct., Allendale, NJ 07401.

CIRCLE NO 115

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## C-CODE CASE TOOL

MicroStep is a CASE tool that produces 100% C source code and executable programs directly from graphics specifications. The tool features an interactive graphics-design environment, automatic specification analysis, generation of executable code, and production of technical documentation. You can interactively create a system specification using five sets of seamlessly integrated tools to build the data flow diagrams, specify the data structures, lay out the screens, format the reports, and describe the applications computations and processing logic. Additionally, you can copy and store elements in the data dictionary for use in other specifications. Currently, MicroStep accepts .DBF and both fixed and delimited ASCII files. It runs on IBM PCs and compatibles running DOS 3.1 through 3.3. \$5000.

**SysCorp International, 9420 Research Blvd, Suite 200, Austin, TX 78759. Phone (512) 338-0591.**

Circle No 572

## INTERNATIONAL OS

The DR DOS single-user, single-tasking operating system can reside in ROM. Release 3.4 provides many of the features of IBM PC-DOS 4.0 and maintains compatibility with applications written for PC-DOS 3.3. Special features of release 3.4 include a menu-driven installation procedure that provides simplified on-line help, full support for PC-DOS 4.0 disk partitioning, and full

support for LIM 4.0 expanded memory. Earlier versions provided support for double-byte Kanji character sets; this version also allows you to customize the standard text messages by editing text files that are supplied in the Redistribution Kit. English, French, and German versions of these files are available from the vendor and require no extra work.

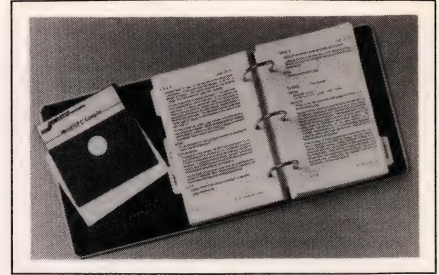
In a RAM-based system, the operating system, including 15 disk buffers and 512 fast-open entries, occupies approximately 72k bytes; in a ROM-based system, the main components of the operating system occupy 88k bytes of ROM, leaving 8k bytes free for other purposes. If you also execute the kernel from ROM, the amount of RAM available for a user's program and data is 604k bytes out of the 640k-byte address space. The advantage of the ROM-based system is that the complete operating system becomes available at power-up time without any disk access. Available only to OEMs and corporate resellers; price depends on volume.

**Digital Research Inc, Box DRI, Monterey, CA 93942. Phone (800) 443-4200; in CA, (408) 649-3896. FAX 408-649-0750. TWX 910-360-5001.**

Circle No 573

## C COMPILER

The MetaStep Microprogram C Compiler lets you define the architecture of the target system by means of machine-definition statements. You can then write your program in C. The compiler works with an augmented version of the vendor's MetaStep microprogram language and performs machine-independent optimizations such as recognition of duplicated expressions, strength reduction, live/dead-code analysis, elimination of common subexpressions, loop rolling and unrolling, and management of constants. The MetaStep micro-



program language system then performs all machine-dependent optimizations and tailors the micro-code to the custom architecture that you define. The package runs on a variety of host computers, including MS-DOS machines, Sun/Unix workstations, and VAX/Unix minicomputers. Single-user MS-DOS machine, from \$4995.

**Step Engineering, Box 3166, Sunnyvale, CA 94088. Phone (408) 733-7837. FAX 408-773-1073.**

Circle No 574

## C DEVELOPMENT KIT

The Transputer Toolset provides a complete C and assembly language development environment for the INMOS Transputer family. The tool set works with a single Transputer or in a Transputer network. The tool set offers optimization facilities and close conformance to the emerging ANSI C standard. The Transputer Toolset includes a C compiler, an assembler, a linker, a librarian, and both a single processor and a network loader. The compiler supports in-line assembly language and can generate in-line code for the C functions, which map into the Transputer instruction set. The compiler can generate code for the 64-bit/32-bit ANSI floating-point model, or the 32-bit-only floating-point model. The tool set is portable across MS-DOS, Apple Mac II, and SYS5/BSD4.3 Unix systems, including Apollo, Sun, and DEC. \$995.

**Logical Systems, Box 1702, Corvallis, OR 97339. Phone (503) 753-9051.**

Circle No 575



## Complex Data Acquisition System Uses Few Components

Richard Markell

### Introduction

Sophisticated filter system designs frequently demand expensive printed circuit boards chock-full of operational amplifiers and precision capacitors. Digital filters require fewer but more expensive devices and a lot of software. However, advances in switched capacitor filters have made the design of elegant filter systems cheaper, easier and much smaller. The system shown in block diagram form in Figure 1 is a good example. It is a typical system for filtering transducer signals. Its input is a DC-to-20kHz signal; its output allows signals to be analyzed in three frequency bands.

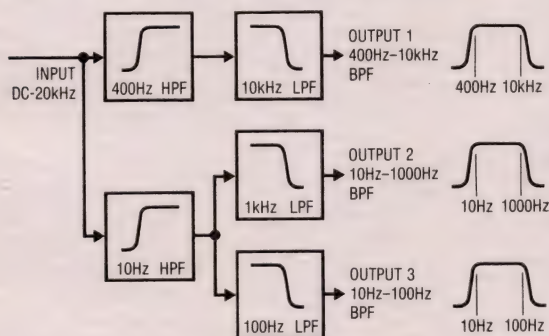


Figure 1. Filter System Block Diagram

### Implementation

A system implemented using switched capacitor filters is shown in schematic form in Figure 2. This implementation uses two LTC1064 quad switched capacitor building blocks and one LTC1062 5th order Butterworth lowpass filter. The system requires the use of one operational amplifier, an LT1007.

### Filter Design Specifications and Test Results

**Filter 1** — a 400Hz-to-10kHz bandpass filter, with passband ripple of 1dB and passband noise of  $200\mu\text{V}_{\text{RMS}}$ , Figure 3.

**Filter 2** — a 10Hz-to-100Hz bandpass filter, with passband ripple of 1dB and passband noise of  $500\mu\text{V}_{\text{RMS}}$ , Figure 4.

**Filter 3** — a 10Hz-to-1kHz bandpass filter, with passband ripple of 1dB and passband noise of  $390\mu\text{V}_{\text{RMS}}$ , Figure 5.

These wideband filters are made by cascading 4th order elliptic lowpass and highpass filters. The single exception is the 5th order Butterworth lowpass filter used in the 400Hz-to-10kHz section.

### System Considerations

The LTC1064 quad switched capacitor filters used are building blocks capable of implementing up to 8th order filters. One LTC1064 implements both a 4-pole elliptic 400Hz highpass filter and a 4-pole elliptic 1kHz lowpass filter. The other LTC1064 implements a 4-pole elliptic 100Hz lowpass filter and a 4-pole elliptic 10Hz highpass filter. The LTC1062 is a 5-pole Butterworth lowpass filter set at 10kHz.

Resistors  $R_{11A}$  to  $R_{H2A}$  implement the 400Hz elliptic highpass filter in Device A. The 1kHz elliptic lowpass filter in Device A is implemented by  $R_{13A}$  to  $R_{44A}$ . Resistors  $R_{11B1}$  to  $R_{42B}$  implement the 10Hz elliptic highpass filter in Device B. The 100Hz elliptic lowpass filter in Device B is implemented by  $R_{13B}$  through  $R_{44B}$ . The LTC1062 is hardware programmed for 10kHz by  $R_{50}$  and  $C_{50}$ .

The 8th order LTC1064 devices allow the use of two sections in the 100:1 clock-to-center frequency mode and two sections in the 50:1 mode. (Resistor programming can then be used to further extend the clock-to-center frequency range to 25:1 for two sections and 250:1 for the other two sections.) This allows decade-wide bandpass filters to be built using only one LTC1064 at one clock frequency.

### Conclusion

This is only one use of the new switched capacitor building blocks, the LTC1064 family of quad switched capacitor filters. These filters have wide flexibility. For example, the 10Hz-to-100Hz filter could be used at 20Hz-to-200Hz simply by doubling the clock, which sets the filter frequency. Similarly, bands of interest could be inspected by sweeping the clock. The devices work with center frequencies as high as 100kHz in circuits with similar simplicity.



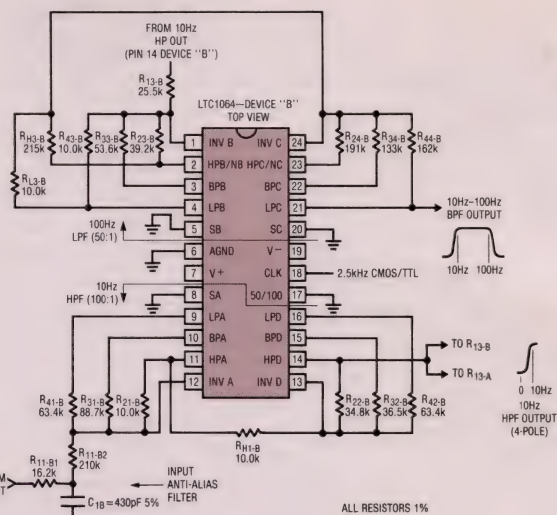
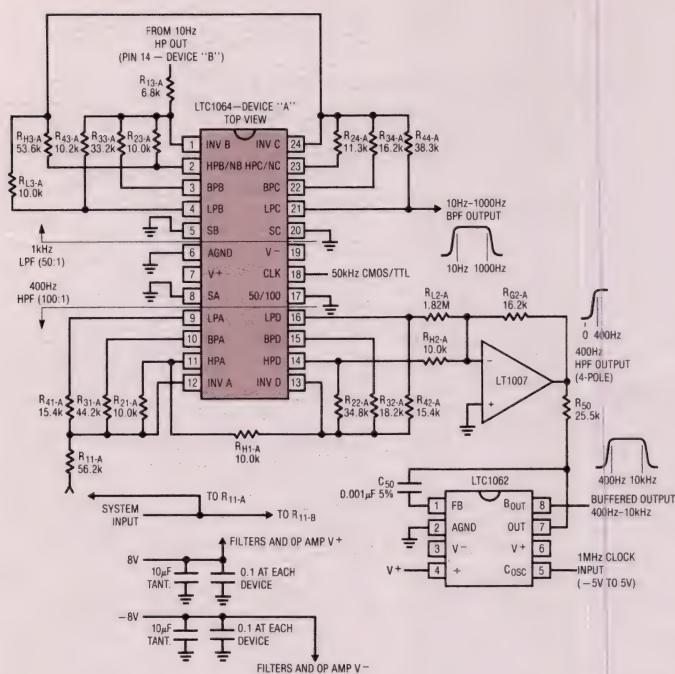


Figure 2. Schematic Diagram

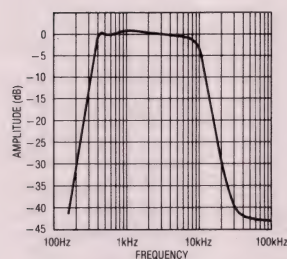


Figure 3. 400Hz-10kHz BP Filter Amplitude Response

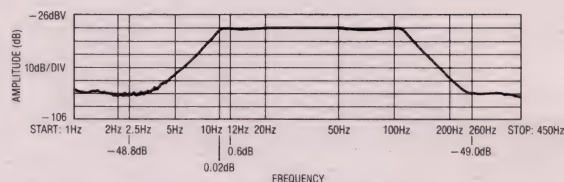


Figure 4. 10Hz-100Hz BPF Amplitude Response

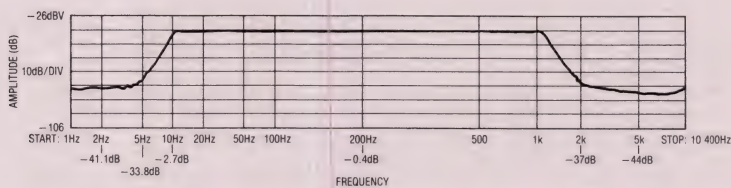
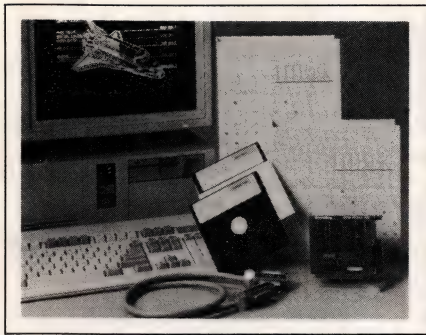


Figure 5. 10Hz-1000Hz BPF Amplitude Response

For literature on our complete filter line, call  
(800) 637-5545. For applications help, call  
(408) 432-1900, Ext. 453.



# Software



## ENGINEER'S BASIC

The HTBasic integrated set of IBM PC and PS/2 programming tools is compatible with Hewlett-Packard's Rocky Mountain Basic for the HP 9000 Series 200/300 computers and has features that make it valuable for process-control, instrumentation, and other complex engineering applications. The package consists of a full-screen, syntax-sensitive editor; the Basic interpreter; and an interactive debugging facility.

Special features include more than 40 graphical statements to control screen displays and plotters; 16 statements for the control of IEEE-488 interfaces; extensive mathematical functions for integer and real data types, as well as matrix operations for matrices with as many as six dimensions and 32,767 elements per dimension; and 12 statements that allow you to define soft-key macros. A Configure statement lets you customize the HT-Basic environment to match that of a Series 200/300 computer, so you can run many existing programs, written in Rocky Mountain Basic without alteration. The package includes utilities that let you copy files from HP LIF format disks to DOS disks. PC versions, \$500; 80386-based machines running PC-DOS, \$800. IEEE-488 drivers and the vendor's IEEE-488 interface card are available as options at additional cost.

**TransEra Corp., 3707 N Canyon Rd, Provo, UT 84604. Phone (801) 224-6550. FAX 801-224-0355. TLX 296438.**

Circle No 563

## CASE TOOL

Sylva Foundry MS/DOS is an IBM PC-based workbench that contains tools for creating and modifying techniques, interfacing open architecture with other tools, and generating diagrams from external data. Once you create modeling objects, you can store them in technique-specific Icon Drums for use in creating system models. A diagram editor provides a rule-based drawing capability through an intuitive interface. The Foundry Diagram Generator lets you generate diagrams from external data, and the Foundry Screen Maker lets you create active menus and panel-to-panel relations and control other screen functions. An optional Starter Kit enables you to modify or blend DeMarco Data Flow, Gane and Sarson Data Flow, Ward-Mellor Control Flow, Entity Relationship, State Transition, Constantine Structure, and three other techniques. \$8500. Starter Kit, \$3000.

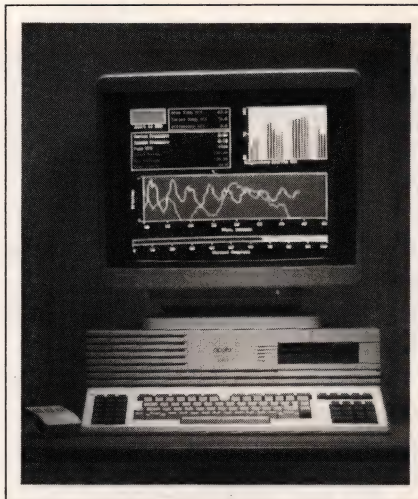
**Cadware, 869 Whalley Ave, New Haven, CT 06515. Phone (800) 223-9273; in CT, (203) 397-2908.**

Circle No 564

## LABTECH FOR UNIX

LabTech NoteBook, a scientific data-acquisition package, was formerly available only for IBM PCs and compatibles. Now it's available to run on Apollo workstations under the Apollo Domain/OS, a Unix implementation that supports both the Berkeley 4.3 and the AT&T System V release 3 standards. The program is menu-driven and lets you acquire real-time data of many types, such as analog, digital, thermocouple, strain-gauge, and counters.

You can collect data from as many as 16 devices at rates as slow as one point every three years or as fast as your hardware allows; the program continuously writes the data to a disk file during acquisition. You can also perform real-time calculations, analysis, and signal



processing on the incoming data. The processing capabilities include fast Fourier transforms of real and complex waveforms. An application interface lets you store data in, or retrieve it from, spreadsheets such as Lotus 1-2-3, RS/1, or user-written programs. Control features allow you to customize the instrumentation interface so that any operator can run experiments. 3500 Series workstations, \$2000; 4500 Series workstations, \$5500.

**Laboratory Technologies Corp., 400 Research Dr, Wilmington, MA 01887. Phone (508) 657-5400. FAX 508-658-9972.**

Circle No 565



## LANGUAGE EDITOR

The BSO/LSE+ user-interface package integrates the vendor's Pascal and C compilers, assembler, and symbolic debugger with the VAX Language-Sensitive Editor (LSE) and with other VAX software-development tools. The package also provides comprehensive



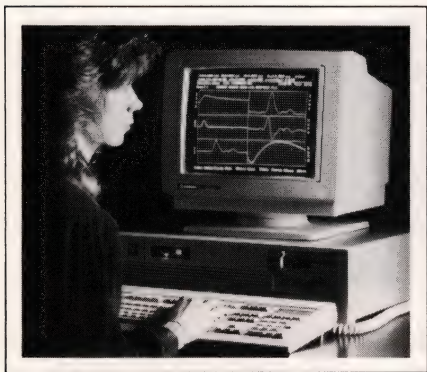
# Software

on-line help for general language-related questions or for specific inquiries about LSE templates and their elements. The VAX LSE provides C and Pascal programmers with a fast and efficient way to enter source code, while automatically eliminating many routine errors such as a missing semicolon, unmatched parentheses or braces, and many common syntax errors.

Without leaving BSO/LSE+, you can then compile, assemble, link, and debug your program. You can also execute normal VAX DCL commands, and a dual-window feature lets you edit a file in one window, while executing DCL commands or reading MAIL in the other; it also lets you execute your program in one window, while viewing the associated source code in the other. BSO/LSE+ runs on any VAX model under version 4.4 or higher of the VMS operating system; you also need version 2.2 or higher of the VAX LSE. From \$500.

**Boston Systems Office, 411 Waverly Oaks Rd, Waltham, MA 02154. Phone (800) 458-8276; in MA, (617) 894-7800. FAX 617-642-5762. TWX 710-324-0760.**

**Circle No 566**



## SOFTWARE SCOPE

Snapshot Storage Scope Release 3.0 is a greatly enhanced version of the vendor's real-time analog data-acquisition, -display, and -storage program. You can now acquire as many as 80 channels of ana-

log data at sampling rates as high as 1M samples/sec, depending on the performance of your analog I/O boards. The program runs on IBM PC/XTs, PC/ATs, and compatibles, and works with analog I/O boards from Acrosystems, Analog Devices, Burr-Brown, Contec, Data Translation, and MetraByte. The program can display as many as eight channels simultaneously, define different units and labels for each channel, and average trigger-synchronized waveforms. You can define a title for each frame of data, and optionally write data to disk in a special format that occupies less than one-eighth the space of standard ASCII files. Other capabilities include real-time acquisition with 12-, 14-, or 16-bit accuracy. \$495.

**HEM Data Corp, 17336 Twelve Mile Rd, Suite 201, Southfield, MI 48076. Phone (313) 559-5607. FAX 313-559-8008.**

**Circle No 567**

## ADA FOR 80386/UNIX

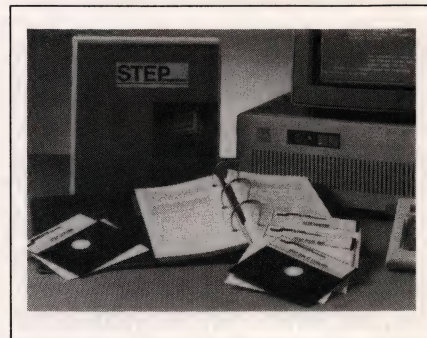
DACS-386/UNIX is a fully validated Ada software-development system that meets all of the Ada and Unix requirements mandated by the Department of Defense. The complete package consists of an Ada compiler, a symbolic debugger, and a set of cross-compilation extensions (DARTS) that includes an Ada runtime system for embedded systems. The compiler runs on 80386-based Unix machines and provides all the standard features of Ada, including tasking, generics, exception handling, elaboration, overloading, and in-line expansion.

The compiler also provides the optional features of Ada that are intended for real-time embedded systems; these features include bit-level representation clauses and fast-tasking context switches. The DARTS (DDC-I Ada Run-Time System) extensions provide cross-compilation, linking, and downloading facilities for real-time embedded

systems that will use the Ada runtime system instead of a full operating system. Compiler, \$3995; symbolic debugger, \$1995; DARTS extension, \$19,995.

**DDC-I Inc, Box 37767, Phoenix, AZ 85069. Phone (602) 944-1883.**

**Circle No 568**



## RISC TOOL SET

The 29000 RISC Support Tools package contains software development tools that work in conjunction with the vendor's Adapt29K hardware-development and prototyping tool for AMD's 29000 RISC processor. The package consists of a C compiler, a source-level debugger, and a cross-assembler. The C29K is a globally optimizing C compiler that conforms to the proposed ANSI C standard and includes runtime libraries, an assembler, a linking loader, and an object-module librarian. The XRay29K debugger lets you set breakpoints at C statements or line numbers, or at assembly-language instructions or memory references. The Step29K cross assembler is a relocating macroassembler, which comes with a linking loader, object-module librarian, and math support. Both the debugger and the cross-assembler run on a variety of host computers such as IBM PCs and compatibles, engineering workstations, and VAX minicomputers. You can download object files to the 29000 target in hex formats and other structures via a serial link.

The Adapt29K hardware prototyper provides a 4096 x 128-bit

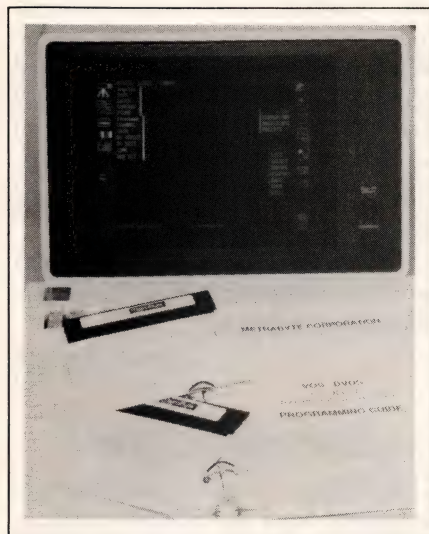


# Software

trace buffer that captures 29000 bus signals at speeds as high as 40 MHz. ROM-resident monitor software in the Adapt29K lets you set and display registers, disassemble and display captured bus activity, and trace instruction execution in single or multiple steps. XRay29K source-level debugger, \$1780; Step29K cross-assembler, \$1000; Adapt29K prototyper, \$8500; C29K compiler, \$1850; 29000 RISC Support Tools package, \$12,130.

**Step Engineering, Box 3166, Sunnyvale, CA 94088. Phone (408) 733-7837. FAX 408-773-1073.**

Circle No 569



## VISION OS

The VOS/DVOS icon-based operating system runs on the IBM PC, PC/XT, PC/AT, and compatibles and gives you full control of micro-computer-based imaging applications. The icon-based user interface lets you set up hardware, manage the screens, define touch zones, and, using DVOS, lets you create or change icons. The system provides camera functions, frame-grabber functions, disk functions, and access to user-defined functions written in C. The imaging functions let you define the kernel and perform convolution, and define and execute bit-mapped operations. The on-line help facility provides a guide

to all VOS functions. In the Record mode, the system stores all point-and-click operations in a disk file that you name; you can repeat the same sequence of operations by recalling and executing this file. VOS, \$99; DVOS, including VOS, libraries, and icon-editing facilities, \$499.

**MetraByte Corp., 440 Myles Standish Blvd, Taunton, MA 02780. Phone (508) 880-3000. FAX 508-880-0179. TLX 503989.**

Circle No 570

## REAL-TIME KERNEL

MTOS-UX/386 is a multiprocessing, multitasking, real-time operating system for 80386-based computers. This OS normally runs in the 32-bit, protected mode of the 80386 and protects system resources such as block and memory pools, message buffers, controlled shared variables, and task resources. Also available is a version that uses the multisegmented memory model to run MS-DOS software. This model protects the kernel and the system resources by means of task privilege levels. You can increase the computing power of the system merely by adding as many as 16 CPUs; changing the number of CPUs does not require any change to the application programs. The development kit includes test facilities, debugging tools, validation programs, configuration programs, a RAM-disk driver, a Unix interface, and a C-portable library. The symbolic debugger provides task-level debugging facilities. Because all versions of MTOS-UX have the same programmer interface, programs written in a high-level language will run under any version of MTOS-UX, regardless of the processor type. Development kit, from \$5000.

**Industrial Programming Inc., 100 Jericho Quadrangle, Jericho, NY 11753. Phone (516) 938-6600. TLX 429808. FAX 516-938-6609.**

Circle No 571

## Free Intel Language

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**intel**

## POWER TOOL.



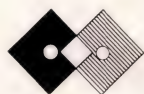
CIRCLE NO 25



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CIRCLE NO 26

## DID YOU KNOW?

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U.S., France, and Germany.

### EDN

## Software

### MODELING LANGUAGE

GAMS (General Algebraic Modeling System) is a high-level programming language that lets you formulate complex optimization problems by means of concise algebraic statements. When constructing models, you can use arithmetic and relational operators, indexing, functions, and exception-handling logic. You can enter data in basic forms, either by direct assignment or in table form. You can specify data transformations in algebraic form, and the program will perform the calculations. The complete package consists of the GAMS compiler, which has extensive error-checking and -reporting facilities and built-in report-writing features; the solver Minos for large linear and nonlinear problems; and the solver Zoom-XP for mixed-integer problems. PC version, \$1600; workstation version, \$3200; mainframe version, \$6400.

*The Scientific Press, 507 Seaport Ct, Redwood City, CA 94063. Phone (415) 366-2577.*

Circle No 634

### C CROSS-DEBUGGER

The XDB 5.0 C source-level cross-debugger runs on IBM PCs and on VAX, Sun, Apollo, and Hewlett-Packard workstations. Using the host—with or without an in-circuit emulator—you can debug C programs for target systems that are based on the Intel 8086, Motorola 68000 and 6800, NEC V, and Zilog Z80 family processors, or on the Am29000 RISC processor. Ten new windows allow you to view source code, XDB commands, registers, monitored variables, stack contents, and simulated input and output; you can also view the active breakpoints and all user-defined functions.

If you're using the XDB with an in-circuit emulator (ICE) in the target, you can interrogate the ICE's trace buffer and obtain an execution



# Software

history. The simulated-I/O feature lets you debug your own input and output routines before the actual hardware devices are connected to the target system. The user-defined-function feature lets you store and recall complex commands and expressions with only a few keystrokes. IBM PC versions, from \$1500.

**Intermetrics Inc, 733 Concord Ave, Cambridge, MA 02138. Phone (617) 661-0072. TWX 710-320-7523.**

Circle No 635

## WINDOWING TOOL

The Xsight windowing system runs on 80386-based computers under Unix System V, release 3. The package lets you divide your screen into multiple windows, each of which runs a different Unix application program. The package works with the vendor's Merge 386, which allows you to run DOS applications and Unix applications concurrently on 80386-based systems. If your personal computer is networked to a Unix host, Xsight lets you call up, monitor, and control multiple DOS and Unix applications on any node in the network. \$695.

**Locus Computing Corp, 9800 La Cienega Blvd, Inglewood, CA 90301. Phone (213) 670-6500. FAX 213-670-2980.**

Circle No 636

## C LIBRARY

/\*resident\_C\*/ is a library of C routines for building terminate-and-stay-resident (TSR) programs. The C routines let you build interrupt-service routines, such as timers that schedule a program to run at a particular time. You can also build resident shared libraries that can be accessed by any number of programs. The library also allows you to convert existing C programs to TSR status by adding a few function calls.

Other routines included in the li-

brary let you save screens or windows so your TSR program won't disrupt the program that it interrupts. Versions of the library are available for the Microsoft (QuickC and C 5.0), Borland (Turbo C), and Lattice C compilers that run on IBM PCs and compatibles. The distribution disk includes demonstration programs that show you how to use the library and how to build shared libraries. Binary version, \$99; binary and source code, \$198.

**Essential Software Inc, 76 S Orange Ave, Suite 3, South Orange, NJ 07079. Phone (201) 762-6965.**

Circle No 637

## ADA TOOL KIT

The ADADL (Ada Design Language) set of 25 integrated software-development tools helps you meet DoD standards. The program-design-language (PDL) tools allow you to create high-level abstractions (pseudocode) in a structured form of English, then compile them. The rule-checking tools can detect and flag omissions, contradictions, and inconsistencies in the pseudocode so that you can correct these errors before they become embedded in formal Ada code. The tools also include a certified Ada compiler and comply with DoD mandate 3405.2.

Analytical tools can quantify the complexity of the overall design and the executable Ada code derived from it. Other analytical tools can produce an audit trail that allows you to trace requirements from the system specifications to the individual program units that satisfy these requirements, and vice versa. The tool kit also provides project-management and documentation facilities. From \$7150 for workstation versions to \$15,700 for mainframe versions.

**Software Systems Design Inc, 3627 Padua Ave, Claremont, CA 91711. Phone (714) 625-6147.**

Circle No 638

**\$3,000 Each.  
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At this price, no 80C196 programmer should be without one. To order, or for more information, call:  
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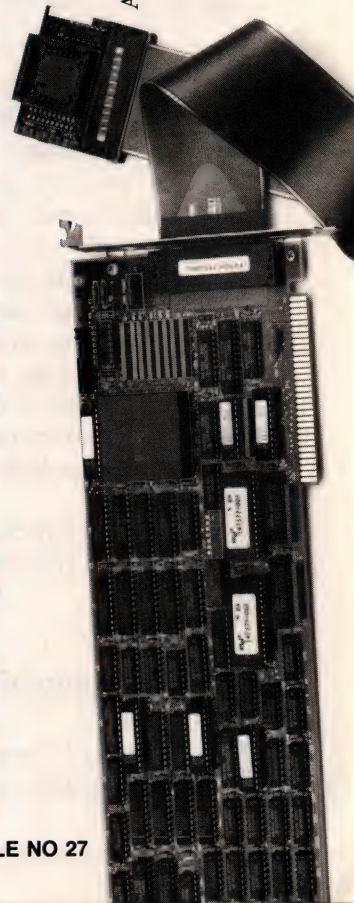
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**LOW PRICE PC ICE.**

There is a low-cost 80C196 emulator that lets you debug your software *before* target hardware is available. One that supports in-target debug in real-time. Provides full symbolic support. And displays your source code during debug. All from your PC-AT\* host. All for \$3,000. And best of all, it's a Genuine Intel emulator. The ICE™-196KB/PC Emulator.

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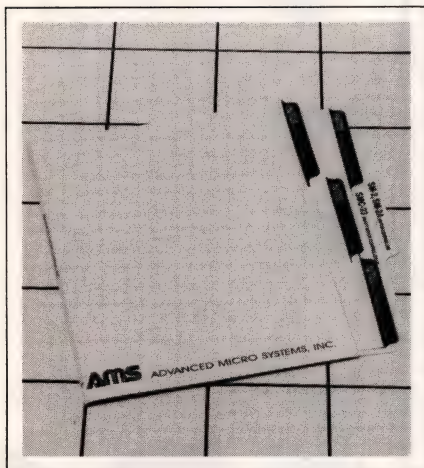


## Handbook features data-acquisition interfaces

The vendor's product handbook No 19 surveys the complete line of data-acquisition, industrial-control and monitoring, signal-conditioning, and communications products for IBM PC/XT, PC/AT, PS/2, Apple II, and VME Bus computers. The 260-pg publication also features application notes, selection guides, and price information.

**MetraByte Corp**, 440 Myles Standish Blvd, Taunton, MA 02780.

Circle No 599



## Guide focuses on motion control and vision systems

The 10th anniversary edition of the vendor's product guide contains comprehensive data and price information on single-board computers, memory I/O cards, intelligent motor controller ICs and boards, dual-axis chopper design, and high-power driver cards. Also described are video cross-hair generators and digitizers, programmable cross-hair generators, and high-power driver cards.

**Advanced Micro Systems Inc**, 31 Flagstone Dr, Hudson, NH 03051.

Circle No 600

## Personal-computing tools cataloged

*The Catalog of Personal Computing Tools for Scientists and Engineers*



contains product reviews by the vendor's technical staff. Most of the products have special ratings, indicating "the best" available for features and performance, and "the only" way to do a job. The catalog offers a 60-day risk-free return period. Featured in this 40-pg 10th edition are the Acquisition Engine; an intelligent 8-port data communications board and an 8-port board for the PS/2; a 3-D CADD system; an "at-speed" individual RAM chip tester; 3-D graphics software; and an expanded line of computer security products.

**Personal Computing Tools Inc**, 17419 Farley Rd, Los Gatos, CA 95030.

Circle No 601

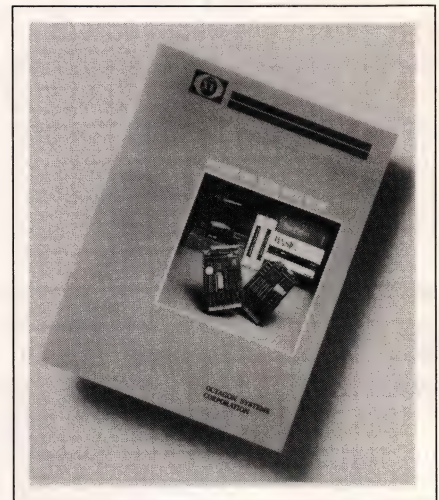
## Extensive catalog of board-level devices

According to the vendor, the 1989 product catalog presents the largest selection of board-level products in the industry, as well as the most diversified array of hardware and software components. The main product categories are Intel- and Motorola-based processors; static and dynamic memories; serial, parallel, and analog interfaces; controllers for disks, graphics, data communications, networking, and motor control; and accessories such as

card cages, cables, and backplanes. A new product category offers linear scan cameras and controllers. In the software section, you'll find a library of software drivers for most of the vendor's boards, software development utilities, real-time operating systems, and high-level languages. Another important section deals with ready-to-use development systems and OEM computers.

**Gespac Inc**, 50 W Hoover Ave, Mesa, AZ 85210.

Circle No 602



## STD Bus development system

The vendor's 36-pg catalog *PC/XT on the STD Bus* outlines the STD-XT line of microcontrollers, peripherals, and accessories. The publication provides technical information about the STD-XT CPU card, support card, floppy-disk card, and hard-disk drive. It also discusses STD-XT development systems and related accessories.

**Octagon Systems Corp**, 6510 W 91st Ave, Westminster, CO 80030.

Circle No 603

## Brochure comments on single-board computer

This 6-pg brochure illuminates the vendor's Intel-compatible Multibus I 80386 single-board computer. The



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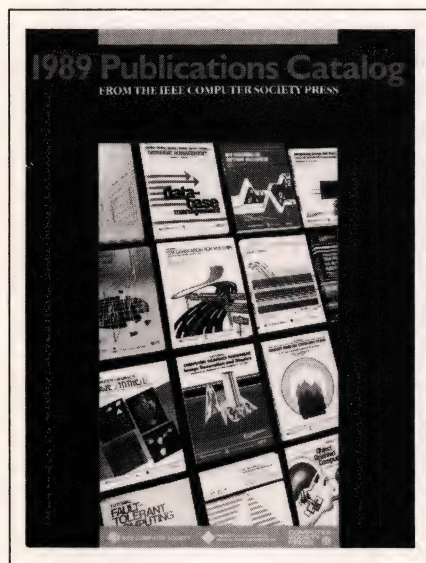




4-color publication features photographs, a technical description, and complete specifications for the CD21/8386 SBC, which features items not found on Intel's board, such as two SBX connectors, on-board sockets for both the 80387 and Weitek 1167 numeric processors, and onboard DMA.

**Central Data**, 1602 Newton Dr, Champaign, IL 61821.

**Circle No 604**



## Inventory of technical books for engineers

The *1989 Publications Catalog of the IEEE Computer Society* provides a voluminous listing of professional-level technical books for com-

puter scientists and engineers. Sixty new books have been added to the list since the publication of the 1988 catalog. The 28-pg publication is divided into sections entitled Coming Soon from CS Press, Monographs (a new category), Tutorials by Subject, Conference Records & Proceedings, Special Book Packages, ANSI/IEEE Standards, Master Publications Listing & Price List, and Membership Information.

**The IEEE Computer Society**, 1730 Massachusetts Ave NW, Washington, DC 20036.

**Circle No 605**

## Computer numerical control for factory-floor environment

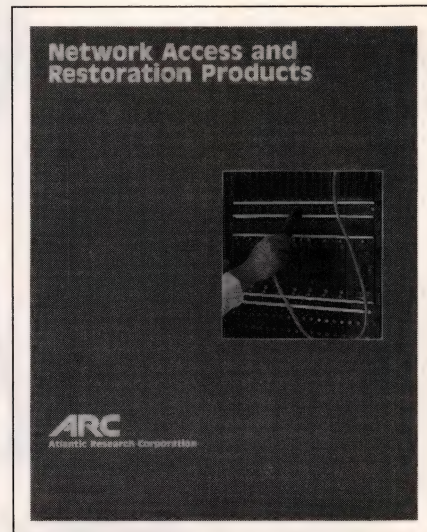
Excerpted from the vendor's 5-volume *Manufacturing Automation Series*, the 42-pg report, "Numerical Control Overview," reviews the use of CNC (computer numerical control) systems in factory-floor environments. Comparison columns cover applications; control, operating, and programming features; diagnostics; and physical attributes of 47 numerical controllers from 18 vendors. The publication also outlines numerical control programming languages and systems, helps you select a CNC system, and analyzes how CAD/CAM systems affect a CNC system in a computer-integrated manufacturing environment. \$35.

**Datapro Research**, 1805 Underwood Blvd, Delran, NJ 08075.

**INQUIRE DIRECT**

## Brochure presents network-access products

This 24-pg brochure describes the vendor's complete line of network-access and restoration products. The booklet covers digital, VF, and coaxial patching and switching equipment; interface converters; the Restorer multiline dial-backup system; NTS network management systems for data; the Artacs PBX



Management system for voice; and Interview Series test instrumentation.

**Atlantic Research Corp**, Teleproducts Div, 7401 Boston Blvd, Springfield, VA 22153.

**Circle No 606**

## Understanding the European telecommunications industry

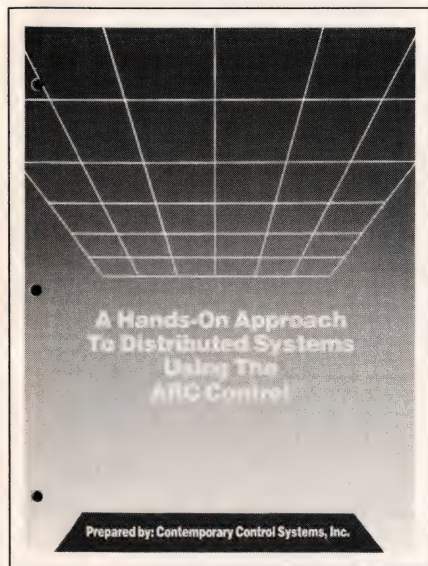
*European Telecommunication Organisations* is a study that provides basic telecommunications-industry information about 10 European countries in anticipation of the completion of the European market in 1992. Conducted under a grant from the European Commission's FAST program, the Anglo-German Foundation, Alcatel NV, and the German Ministry of Technology, the study includes an introductory chapter that presents the structure, functioning, and evolution of European telecommunications systems. In section 1, an expert from each country discusses regulatory bodies, the extent of the national carrier's monopoly, and the relationship between the carrier and the national telecommunications manufacturing industry. The second section attempts to analyze the effects of the current institutional arrangements. Finally, the third section comments on probable regulatory and institutional changes. The docu-



ment includes a glossary of technical terms.

**Nomos**, Box 610, 7570 Baden-Baden, West Germany.

Circle No 607



## Discussion of distributed control systems

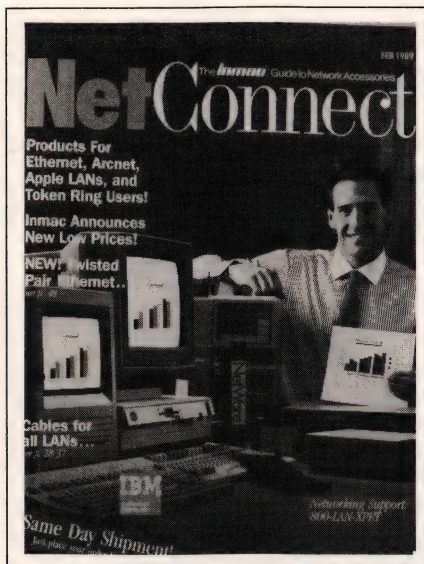
*A Hands-On Approach to Distributed Systems Using ARC Control* discusses the design and application of ARC Control, an IBM PC or compatible bus-based intelligent I/O subsystem. The 74-pg handbook provides figures, photos, and tables and concludes with four appendixes containing an acronym guide, answers to ARC-control questions, references, and a component list that provides power-consumption requirements.

**Contemporary Control Systems Inc.**, 2500 Wisconsin Ave, Downers Grove, IL 60515.

Circle No 608

## Catalog for LAN users

*NetConnect* is a 48-pg direct-mail catalog that features more than 500 computer networking products for LAN users. The 4-color publication provides product diagrams, illustrations, and cross-reference charts (where appropriate) to ensure customers that the products they order



will connect with their intended peripherals. The catalog also provides useful hints, such as comparing the merits of twisted-pair with fiber-optic cabling, or Ethernet with token-ring networks.

**Inmac**, Box 58031, Santa Clara, CA 95052.

Circle No 609



## User's manuals for RISC $\mu$ P family

These two user's manuals provide technical information about the vendor's 88100 CPU and 88200 cache/memory-management unit, which are part of the vendor's 88000 RISC (reduced-instruction-set computer)  $\mu$ P family. The two publications serve as references for system designers and software developers. They feature explanations of the addressing modes and instruction sets, analyses of bus operations and

register usage, data about electrical characteristics, and outlines of minimum system configurations. \$2.65 each.

**Motorola Inc.**, Literature Distribution Center, Box 20912, Phoenix, AZ 85036.

INQUIRE DIRECT



## Specs on Transputer-based parallel-processing products

This 24-pg catalog, *Performance by Paracom*, details a complete line of parallel-processing products. The publication describes all of the company's boards and systems based on the Inmos Transputer chip. Categories in the catalog include bus-based boards, boards without buses, systems, software compilers, and development systems. The catalog also presents tutorials on Transputer technology, system architecture, and integration and applications. The three levels of products described are MultiCluster units, MegaCluster, and SuperCluster.

**Paracom Inc.**, Bldg 9, Unit 60, 245 W Roosevelt Rd, West Chicago, IL 60185.

Circle No 610





## Guide to thermistor housings and mounts

The *Thermistor Sensor Handbook* is a comprehensive guide to selecting protective housings and mounts for negative-temperature-coefficient thermistors. The 202-pg book provides technical data on materials and configurations, and gives you the information needed to measure or control the temperature-related parameters on almost any substance or process.

**Thermometrics Inc.**, 808 US Highway 1, Edison, NJ 08817.

Circle No 576



## Assortment of EMI filters

This 20-pg catalog surveys a series of EMI filters, including ac, dc, 3-

phase, special-application, and custom-design devices. Application notes, a filter-selection guide, and ordering information are included.

**Filter Concepts Inc.**, 2624 S Rousselle St, Santa Ana, CA 92707.

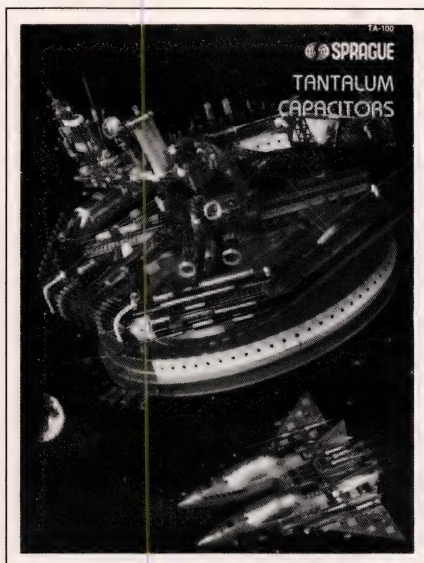
Circle No 577

## Catalog presents surface-mount devices

A comprehensive, 4-color brochure sums up the vendor's full line of surface-mount devices, including monolithic ceramic capacitors; tantalum-and aluminum-electrolytic capacitors; thick-film and precision MELF (Metal Electrode Face Bonding) resistors; and surface-mount trimmers. The leaflet includes cutaway illustrations and application notes.

**Mepco/Centralab**, Box 10330, Riviera Beach, FL 33404.

Circle No 578



## Tantalum capacitor specs

This listing of part numbers and ratings for the company's 27 solid, wet, and foil tantalum-capacitor types also describes 27 styles covered by MIL-C-39003 and MIL-C-39006. The 220-pg manual includes an introduction, parameter comparison charts, and cross-reference tables by type number.

**Sprague Electric Co.**, Technical Literature Services, Box 9102, Mansfield, MA 02048.

Circle No 579



## Synchro-conversion product selection

The *1988/89 Synchro-Conversion Product Selection Guide* focuses on the vendor's line of synchro-conversion components and instruments. The booklet presents synchro/resolver-to-digital and digital-to-synchro/resolver converters, and synchro/resolver instruments such as the L200 dynamic-angle synchro/resolver simulator. The publication includes a reader service card for ordering product data sheets or for inquiries.

**Natel Engineering Co Inc.**, 4550 Runway St, Simi Valley, CA 93063.

Circle No 580

## Data sheet explains synchro/resolver converter

This data sheet deals with the company's HSRD1056RH synchro/resolver-to-digital converter. The 4-pg publication describes the converter and presents its specifications, features, and applications.

**Natel Engineering Co Inc.**, 4550 Runway St, Simi Valley, CA 93063.

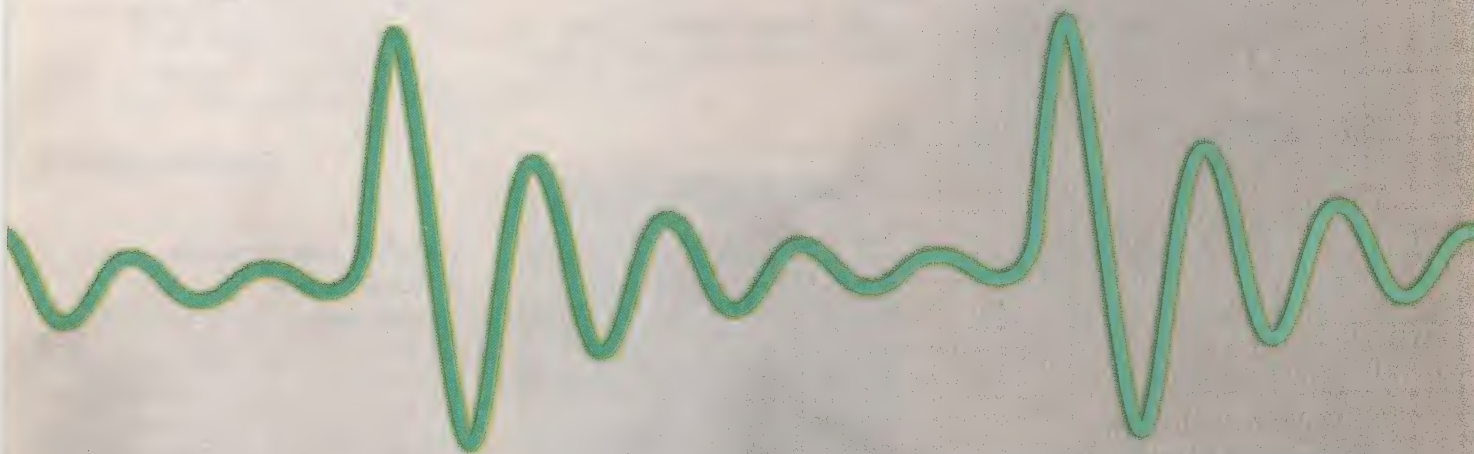
Circle No 581





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The arbitrary function can be captured from your test system by a digital storage oscilloscope, or mathematically defined on the PC. Either way, you can simply download it to the PM 5138, and reproduce it at any time as a reference or test signal.

The PM 5138 is just one of a full range of function, pulse and signal generators from Philips and Fluke - the global alliance in Test & Measurement.

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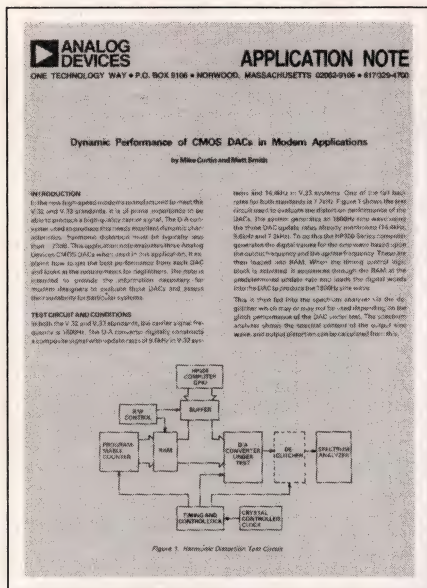
\*For Philips products only.

For countries not listed, write to: Philips I&E, T&M Department, Building HKF 5600 MD Eindhoven, The Netherlands.



**PHILIPS**





## Selecting DACs for high-speed modem designs

The 6-pg application note describes how you can select, use, and evaluate CMOS D/A converters in high-speed modem designs. The note gives examples of test setups and an analysis of measured characteristics. The discussion also examines the harmonic distortion test circuit, methods of generating test signals, appropriate sampling rates, filtering, and the need for a deglitcher in some tests. Oscilloscope photos show the overall spectral response of the DACs under various test conditions.

**Analog Devices Inc.**, Literature Center, 70 Shawmut Rd, Canton, MA 02021.

Circle No 582

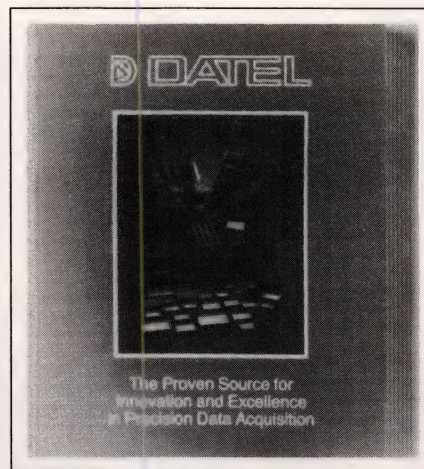
## Synchro handbook

The Synchro Conversion Handbook provides both a practical tutorial and a reference source for designers, systems engineers, and systems users who are involved with synchro products. The publication presents synchro-conversion techniques, data sheets, and a range of topics from the fundamentals of angle-sensing transducers to design constraints and selection criteria for typical applications. In addition, the

book explores not only the company's approach to synchro conversion but also other generally accepted techniques. Charts, diagrams, and tables supplement the text.

**ILC Data Device Corp.**, 105 Wilbur Pl, Bohemia, NY 11716.

Circle No 583



## Wide selection of data-acquisition products

Presented in a complete data-sheet format, the company's 864-pg catalog describes more than 750 data-acquisition products including data-conversion components; thermal printers; calibrators; digital panel meters; filters; power products; process monitors and controllers; and data-acquisition boards. The book highlights MIL-STD-883B and BS9000 products and features application notes.

**Datel Inc.**, 11 Cabot Blvd, Mansfield, MA 02048.

Circle No 584

## Booklet on technology of polymer thick film

The 38-pg booklet entitled "PTF," *A Review of Polymer Thick Film Technology* begins with a historical and technical overview. It emphasizes that PTF materials and processes should not be regarded as a separate and distinct technology but should be used in a supportive

role in relation to printed-circuit etched-copper and thick-film cermet technologies. The booklet advocates the combination of various interconnection technologies to meet the demands of rapidly developing micro-electronic assemblies. £8.90.

**Patintel**, 14 Woodlands, Gosforth, Newcastle upon Tyne, NE3 4YL, UK.

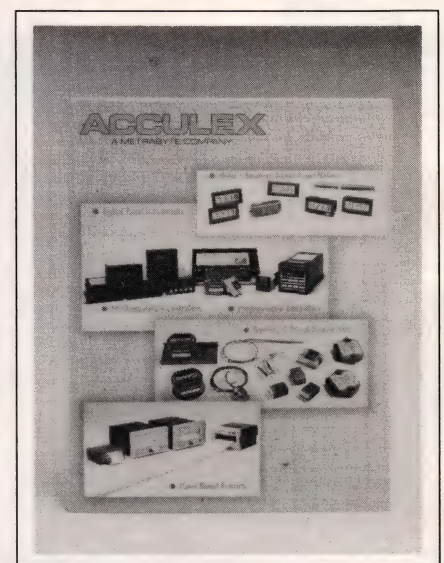
INQUIRE DIRECT

## Catalog lists trimmers on a floppy disk

The company's SpecTrim electronic catalog lists more than 8600 standard trimmer part numbers, providing a software solution to trimmer selection. To find the trimmer data you need, you either define performance parameters or enter the part number. The catalog disk is compatible with IBM PCs, and you can transfer it to a hard disk on a workstation.

**Bourns Inc.**, 1200 Columbia Ave, Riverside, CA 92507.

Circle No 585



## Handbook for industrial design engineers

Intended for industrial design engineers and end users, this 72-pg publication describes the company's products for common industrial ap-



## LITERATURE

plications. The booklet features application notes, wiring diagrams, 4- to 20-mA process loop schemes, suggestions for use, and prices.

**Acculex**, 440 Myles Standish Blvd, Taunton, MA 02780.

Circle No 586

### Wide choice of adhesives, gasketing, and sealants

The vendor's 60-pg catalog contains information about materials for bonding; gasketing; pipe, thread, and hydraulic sealants; retaining cylindrical assemblies; threadlocking devices; electronic assembly aids; solvents, primers, and activators; dispensing systems; and maintenance and repair of equipment. A variety of the products offered meet military specifications, as well as standards set by USDA, USP Class VI for medical applications, Underwriters' Laboratories, and the Nu-

clear Regulatory Commission. The product selector guide summarizes basic technical information about each item.

**Loctite Corp**, 705 N Mountain Rd, Newington, CT 06111.

Circle No 587

### Report on surface treatment

The vendor's 4-pg report explains Longuard, an innovative approach for changing the mechanical and chemical surface properties of metals, composites, ceramics, glass, and plastics. The 4-color publication outlines the applications, advantages, and features of the process and lists the services provided by the vendor. Photographs and charts enhance the brochure's discussion.

**Spire Corp**, Patriots Park, Bedford, MA 01730.

Circle No 588

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```
> Display trace memory [in structured format]
Enter starting addr(hex): 0

0001: Arbitration /80
0003: Select w.ATN /C0
0006: Message-Out/CO(Identify)
0007: Command /12(Inquiry) 00 00 00 00 00 00 00 00 43 4F 4E 4E 45 52 20 20
0008: Data-In /00 00 01 01 29 00 00 00 00 43 4F 4E 4E 45 52 20 20
0010: 43 70 31 34 30 20 28 34 30 60 62 20 33 2E 35 29
0002: 20 30 34 20 42 30 31 33 54 42 20 20 76 20
0003: Status /00
0003: Message-In /00
0030: Bus free
003F: Arbitration w.ATN /80
0041: Select w.ATN /C0
0044: Message-Out/CO(Identify)
0045: Command /08(Head) 00 00 10 01 00
0048: Message-In /0A(DDisconnect)
004C: Bus free
004E: Arbitration /40
0050: Rerelect /C0
0052: Message-In /00(Identify)
0053: Data-In /00 00 00 00 12 34 56 79 12 34 56 7A 12 34 56 7F
0063: 12 34 56 7C 12 34 56 70 12 34 56 7E 12 34 56 7F
```

```
> Display trace memory [in BINARY format]
Enter starting addr(hex): 0

TIME: BSY SEL ATN RST MSG I/O C/D DATA ParErr Exp Time Diff (ns)
0000: A - - - - - 01 ( ) - 00 0 000
0001: A - - - - - 01 ( ) - 00 21 750
0002: A - - - - - 00 ( ) A 00 11 250
0003: A - - - - - 00 ( ) - 00 269 250
0004: A - - - - - A 00 ( ) - 00 145 500
0005: A - - - - - A 00 ( ) - 00 129 000
0006: A - - - - - A 00 ( ) - 00 129 000
0007: A - - - - - A 00 ( ) - 00 138 750
0008: A - - - - - A 00 ( ) - 00 180 000
0009: A - - - - - A 00 ( ) - 00 173 000
000A: A - - - - - A A 00 ( ) - 00 72 250
000B: A - - - - - 01 ( ) - 00 5 455 100
000C: A - - - - - 01 ( ) - 00 29 950
000E: A - - - - - 00 ( ) A 00 13 250
000F: A - - - - - A 0A ( ) - 00 269 250
0010: A - - - - - A 00 ( ) - 00 155 750
0011: A - - - - - A 00 ( ) - 00 138 750
0012: A - - - - - A 20 ( ) - 00 138 750
0013: A - - - - - A 01 ( ) - 00 138 750
0014: A - - - - - A 00 ( ) - 00 138 750
0015: A - - - - - AD ( ) - 00 431 350
```

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## LITERATURE: INSTRUMENTS

### Directory of electronic measuring devices

The company's 1988/89 *Electronic Measuring Instruments* catalog provides a comprehensive listing of 14 instrument categories, including oscilloscopes, logic analyzers, signal generators, modulators, wow and flutter meters, analog and digital voltmeters, and frequency counters/timers. The 213-pg catalog introduces the VP-5516A, a 100-MHz, 4-channel, 10-trace analog oscilloscope featuring a 3-D video display for analyzing complicated waveforms; and the VP-5741A, a DSO featuring a 100-MHz sampling clock and three 10,000-word memories for high-speed transient signals. Divided into product categories that contain general product descriptions, the publication lists specifications and cross references. Diagrams illustrate specific functions.

**Panasonic Industrial Co.**, 50 Meadowlands Pkwy, Secaucus, NJ 07094.

Circle No 589



### Direct purchase service for test instruments

The *Tek Direct Catalog for Instruments, Accessories, and Services* is a quarterly, 4-color publication. Describing a sampling of test-instrument products, this catalog tells

you how to make direct purchases of the vendor's highest volume products. Products highlighted in the latest edition are the vendor's 200 and 2200 Series portable oscilloscopes, the 1205 logic analyzer, accessories, software, and training aids.

**Tektronix Inc.**, Box 500, Beaverton, OR 97077.

Circle No 590



### Supplement supplies instrument information

This catalog supplement provides a broad selection of brand-name test and measurement instruments, including Tektronix and Fluke. Among the products for testing, repairing, and assembling electronic equipment are DMMs, oscilloscopes, EPROM programmers, probes, breakout boxes, precision hand tools, and tool kits. The source book provides specifications, 4-color photographs, and discount pricing.

**Contact East**, Box 786, North Andover, MA 01845.

Circle No 591

### Troubleshooting metastable events

Locating and eliminating component failures caused by random transitions in logic levels is the sub-

ject of the vendor's application note, *Troubleshooting Metastable Events Using the Gated Totalize Counter Feature of the Tektronix 11300A Series Oscilloscope (47W-7008)*. Targeted at people who perform component testing, digital design, and computer peripheral testing, the note explains how to make use of the 11300A Series oscilloscope's writing speed, 750-MHz counter/timer, and oscilloscope functions. Also included are step-by-step instructions on how to set up the oscilloscope and tips on the best way to probe the circuit under test.

**Tektronix Inc.**, Box 1700, Beaverton, OR 97077.

Circle No 592

### Primer explains use of 11300A Series scopes

The *11300A Series Timing Measurement Primer (47W-6783)* instructs you on how to make 10 timing measurements, including propagation delay, pulse interval, and total (event counting) measurements using the company's 11300A counter/timer oscilloscopes. The 24-pg publication also has a reference page that shows how to set up the oscilloscope for different measurements, as well as a glossary and a troubleshooting checklist.

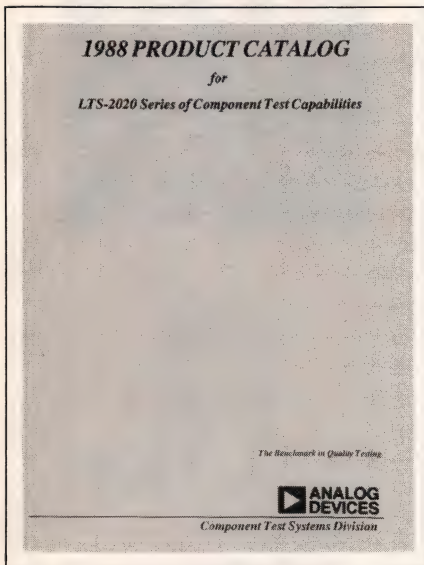
**Tektronix Inc.**, Box 500, Beaverton, OR 97077.

Circle No 593

### Component test system for data-conversion devices

Published in the last quarter of 1988, the company's *Product Catalog for LTS-2020 Series of Component Test Capabilities* deals with the LTS-2020 benchtop component test system, which tests linear and data-conversion devices, and both ac and dc digital and discrete components. The publication describes the LTS system configuration, console specifications and features, and

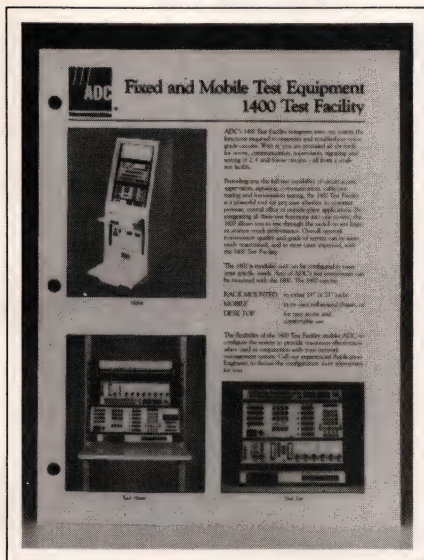




the LTS-2020 development station. An options and supplies section lists peripherals, family boards, socket assemblies, software, interface equipment, and documentation. The book includes specifications, diagrams, photographs, and charts.

**Analog Devices**, 181 Ballardvale St, Wilmington, MA 01887.

**Circle No 594**



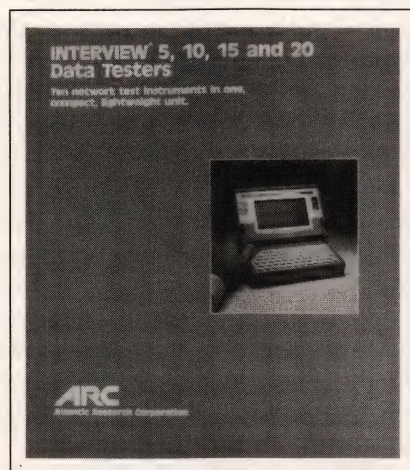
## Brochure depicts fixed and mobile test equipment

The vendor's 6-pg brochure describes the 1400 Test Facility in its three configurations—mobile, rack-mount, and desktop. The pamphlet also discusses the chassis, modules,

and option cards that are available for use with the test facility. A separate section summarizes information about the various test instruments that can be mounted with a 1400 Test Facility.

**ADC Telecommunications Inc.**, 4900 W 78th St, Minneapolis, MN 55435.

**Circle No 595**



## Brochure describes data testers

The company's brochure highlights the features and specifications of the Interview 5/10/15/20 Series of compact, multifunction data testers. The publication summarizes the units' applications for field-service personnel, data-communications technicians, and installation crews, and describes how a single unit performs the functions of 10 different test instruments, such as data-line monitors and protocol analyzers/emulators.

**Atlantic Research Corp.**, Teleproducts Div, 7401 Boston Blvd, Springfield, VA 22153.

**Circle No 596**

## Booklet details high-speed motion-analysis systems

In-depth descriptions and applications data for the EktaPro 1000 motion analyzer and the SP2000-C motion-analysis system are the focus of this 22-pg, 4-color catalog. With



the help of product photographs, charts, and diagrams, the publication describes each unit's features and applications, which include automated manufacturing, transportation systems, aerospace hardware development, packaging, biomechanics, and fluid mechanics. A summary of accessories, sales and delivery terms, and training and service information completes the publication.

**Eastman Kodak Co.**, Spin Physics Div, 11633 Sorrento Valley Rd, San Diego, CA 92121.

**Circle No 597**

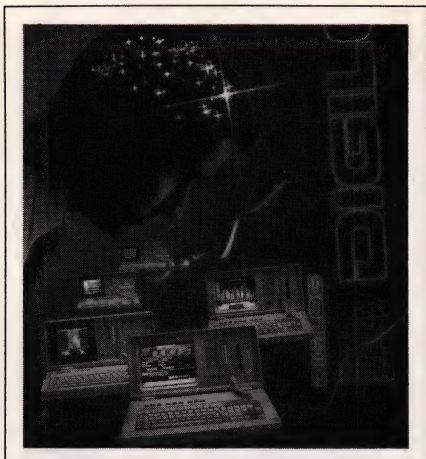
## Brochure on microwave energy generators

This brochure describes the vendor's full line of high-power microwave energy generators for EW/ECM (electronic warfare/electronic countermeasure) emitter simulation. The publication discusses how the generators are used in testing electromagnetic compatibility, EMI, and electromagnetic susceptibility, as well as breakdown testing of antennas and waveguides and evaluation of circulators and electronic components.

**Cober Electronics Inc.**, 102 Hamilton Ave, Stamford, CT 06902.

**Circle No 598**





## Catalog describes protocol analyzers

*The New Wave of Digilog Automatic Protocol Analyzers* presents a wide range of protocol analyzers and applications for field service, data-communications operations, and protocol development, including the vendor's recent models for ISDN analysis/emulation. The 20-pg catalog has display-screen pictures of protocol decodes, response times, and statistical charts that show how you can use the equipment for a variety of needs. Also included are a variety of turnkey applications for automatic monitoring, testing, and analysis of data-line performance. A specifications list completes the catalog.

**Digilog Inc.**, 1370 Welsh Rd., Montgomeryville, PA 18936.

Circle No 630

## Bulletin introduces EPROM programmer

The company's Product Bulletin No P-1287 depicts the Model 7128 EPROM programmer as a high-performance device equipped with microprocessor-based intelligence for ease of use and interface. The bulletin highlights two useful features of the programmer: the compare mode, which allows you to compare source files with programmed devices, and the algorithm-only feature, which programs cells that are different from the

source code. A specification table, a list of commands, and an explanation of diagnostic error codes round out the bulletin.

**Entertron Industries Inc.**, 3857 Orangeport Rd, Gasport, NY 14067.

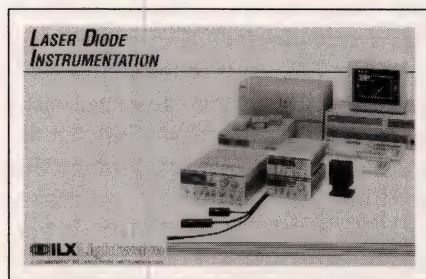
Circle No 631

## Modular system for measuring pc-board copper

This 4-pg brochure introduces the MR 4000 modular-coating thickness-measuring system that helps you select the components that are most suitable for pc-board surface-copper or plated through-hole quality-control requirements. The publication provides complete component specifications and a list that explains the functions of each component. Further, it specifies two statistical packages, standard and "Stats-Plus" for customized header software.

**CMI International**, 2301 Arthur Ave, Elk Grove Village, IL 60007.

Circle No 632



## Fold-out focuses on laser-diode instruments

The vendor's 6-pg fold-out brochure features three recently released products for laser-diode instrumentation and highlights its expansion into custom-built laser-diode test systems. The pamphlet provides specifications, illustrations, and prices.

**ILX Lightwave Corp.**, Box 6310, Bozeman, MT 59771.

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## Paperback deals with 3-D capabilities of AutoCAD

*The AutoCAD 3D Book*, the 4th volume in the AutoCAD Reference Library, acquaints AutoCAD users with the 3-D capabilities of Release 10. The book explains how the 3-D function works and covers new commands, perspective, multiple viewports, surface modeling, and rendering. Also included is a special library of 3-D AutoLisp routines. \$29.95.

Ventana Press, Box 2468, Chapel Hill, NC 27515.

INQUIRE DIRECT

## Answers to questions about pc-board CAD

This 36-pg booklet, *Answers to the Most Commonly Asked Questions on PCB CAD*, provides answers to more than 100 questions about pc-board CAD, compiled from hundreds of conversations with CAD users and potential buyers. Some of the topics include advantages of turnkey vs unbundled systems, pros and cons of different hardware-platform configurations, ways in which training requirements affect the CAD investment, and how to set up a system for maximum efficiency.

Personal CAD Systems Inc, 1290 Parkmoor Ave, San Jose, CA 95126.

Circle No 629

## Starter kit and book for first-time CADD users

The CADD (computer-aided design and drafting) Starter Kit for DOS-based microcomputers and the book, *Converting to CADD: The Generic Software Guide for Businesses*, are easy-to-understand guides that help you learn CADD. The starter kit, which contains a step-by-step tutorial workbook, a symbol library, and a disk of sample drawings, teaches you how to create floor plans, elevations, product

drawings, flow charts, graphs, charts, and other graphical drawings. The book addresses such issues as the transition from manual to electronic drafting, customizing the CADD system to a particular design discipline, and the benefits of using CADD compared with the use of manual drafting. Starter kit, \$159.95; book, \$24.95.

Generic Software Inc, 11911 North Creek Pkwy S, Bothell, WA 98011.

INQUIRE DIRECT

## Update on device modeling

The version 1.1 report on automated device characterization and modeling (ADCM) is a 300-pg update to the version 1.0 ADCM report. The report serves as a product-selection guide and reviews current trends in the field of CAE tools and systems used in semiconductor electrical test and characterization, statistical process control, and device modeling for Spice simulation at the board level and the IC level. Version 1.1 includes two volumes: *Commercial Parametric Test Systems and Data Acquisition Software* and *SPICE Model Parameter Extraction Software*. The publications are based primarily on the authors' experience and extensive vendor interviews, complemented by reviews of product documentation and related publications. First-time purchasers: each volume, \$1300; set, \$2400; version 1.0 owners can purchase each volume for \$395.

Mosec, 10212 Parlett Pl, Cupertino, CA 95014.

INQUIRE DIRECT

## Two training videos for graphics

These two instructional video programs, #D14 *AutoCAD Release 10: For the Beginner* and #D15 *AutoCAD Release 10: Advanced Operations*, provide the materials

for self-instruction at the beginning and advanced levels. The elementary level focuses on the display features and 3-D graphics capabilities of Release 10, and it compares the viewing capabilities of the User Coordinate System with the World Coordinate System. The advanced program also explores 3-D graphics capabilities and introduces Lisp programming and some of Lisp's special features. Both programs include a study guide. \$299 each.

Bergwall Productions Inc, Box 238, Garden City, NY 11530.

INQUIRE DIRECT

## Publication deals with AutoCAD release 10

*AutoCAD: A Concise Guide to Commands and Features*, the most recent publication in the vendor's AutoCAD Reference Library, consists of 40 chapters of AutoCAD's basic features and commands with accompanying exercises for beginning users. The 330-pg softcover book also serves as a reference for seasoned users. More than 200 illustrations complete the issue. \$19.95; with optional disk, \$39.

Ventana Press, Box 2468, Chapel Hill, NC 27515.

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## WHAT'S NEXT

The July 20th issue—Part 2 of EDN's Product Showcase—will contain staff-written articles and product descriptions covering four key technology areas:

- Instruments
- Computers & Peripherals
- Computer-Aided Engineering
- Components.

This issue will also include our regular departments, an expanded literature section, and our semiannual product database index. You won't want to miss it.



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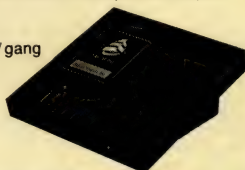
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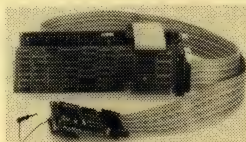


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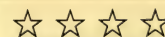
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Page D-1304

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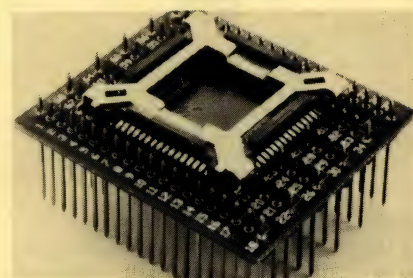
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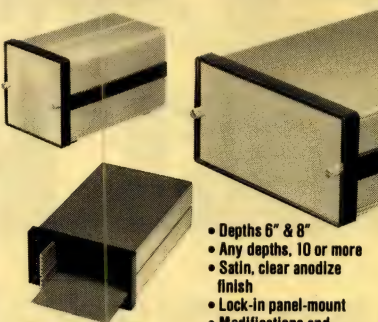
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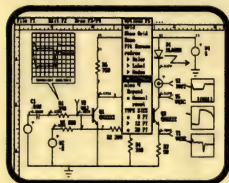
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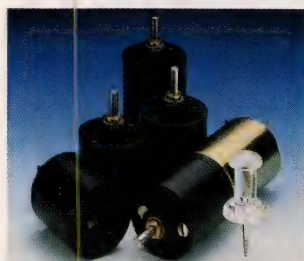
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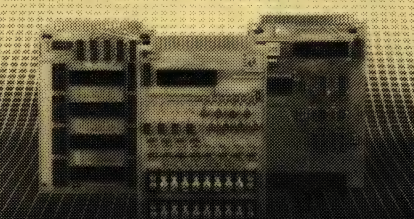
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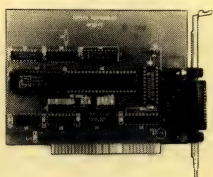


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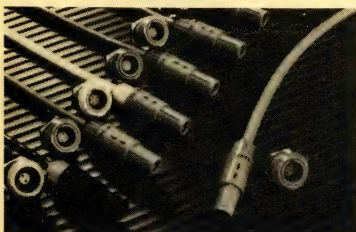
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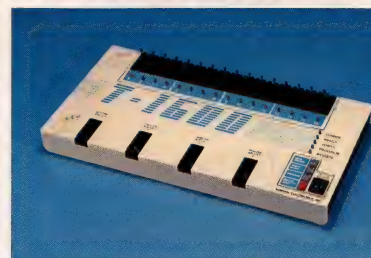


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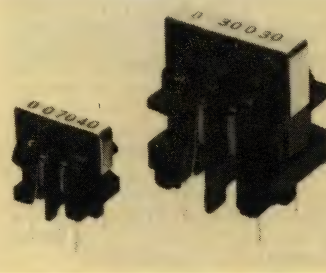
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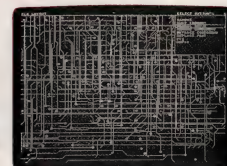
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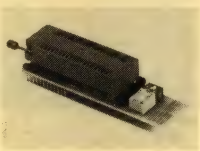
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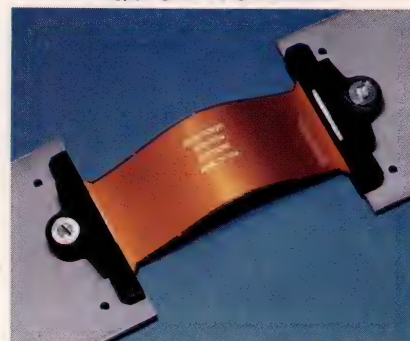
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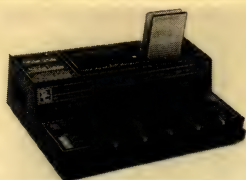


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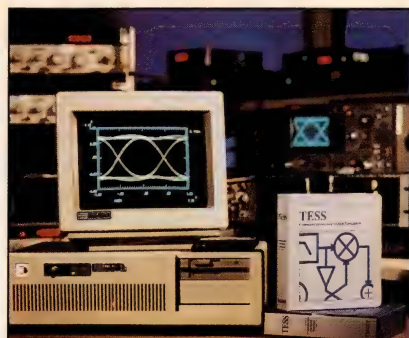
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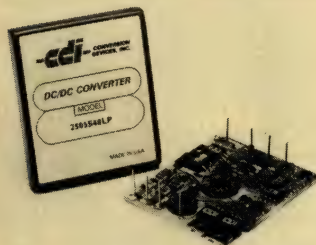
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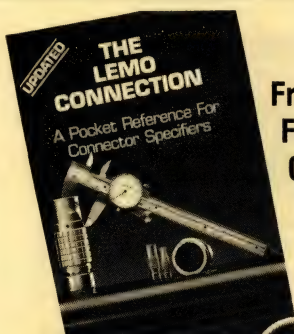


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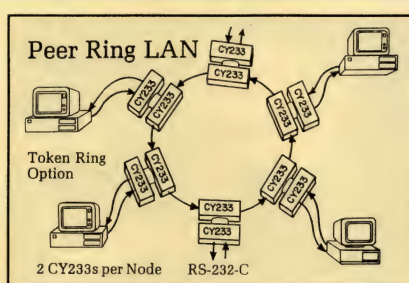
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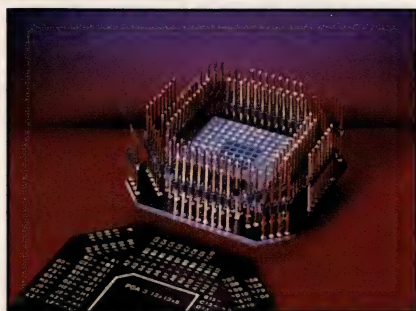


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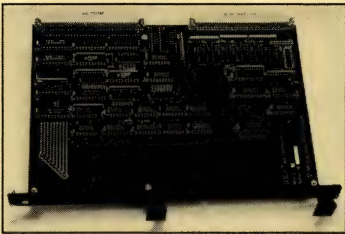
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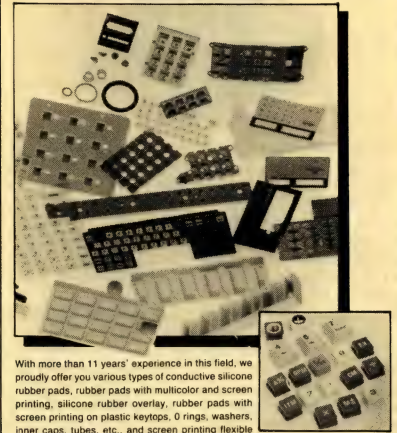
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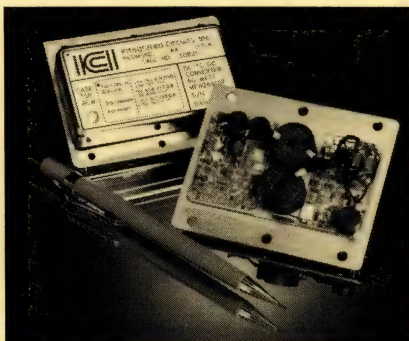


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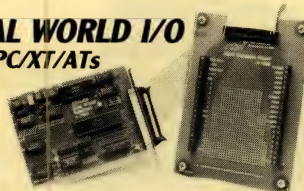
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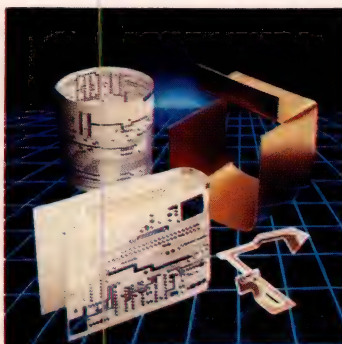
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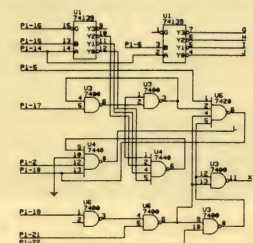
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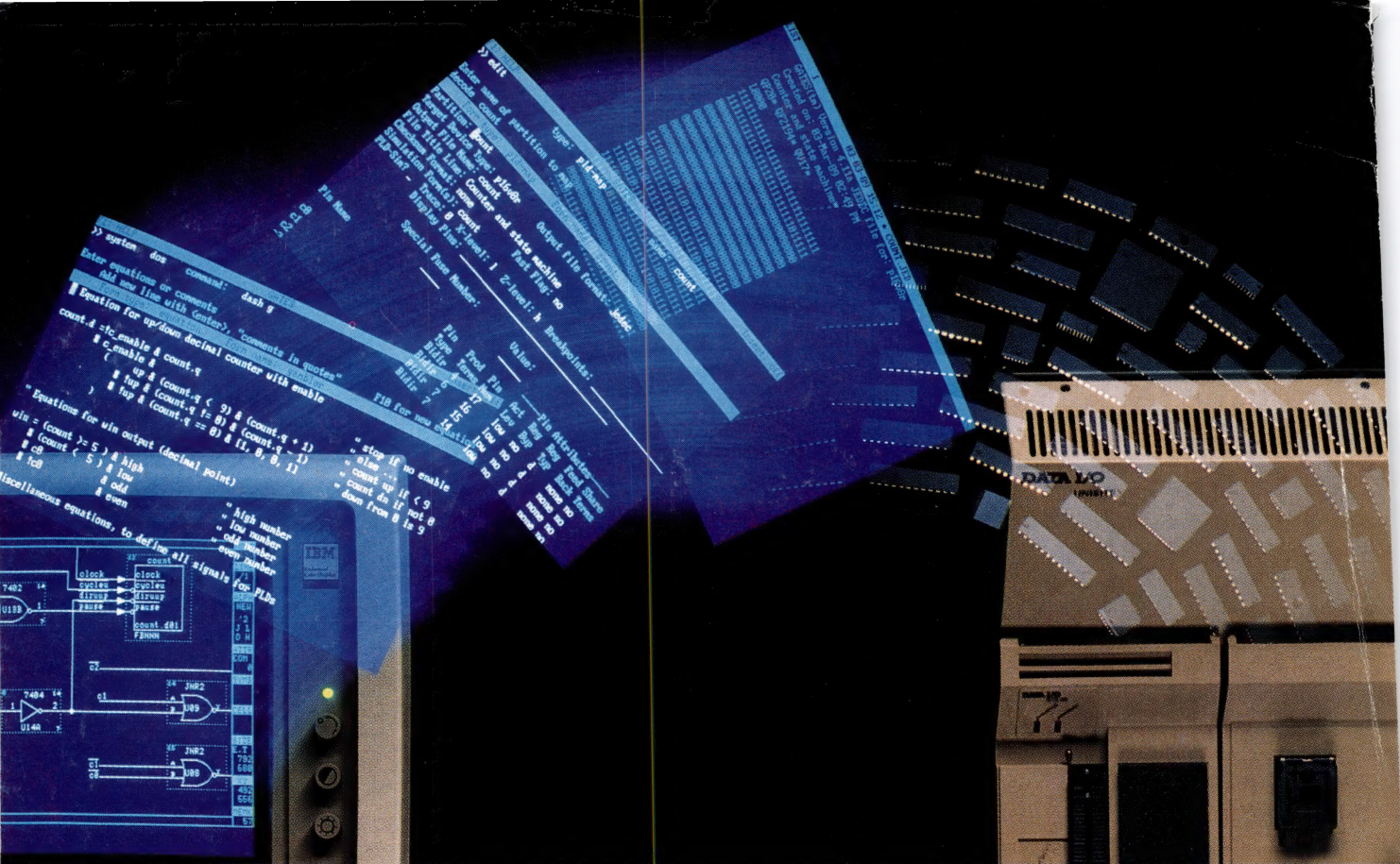
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